Field Sampling Plan for an Engineering Evaluation/Cost Analysis (EE/CA)

Area 7 Pesticide Area of the Additional and Uncharacterized Sites Operable Unit

Crab Orchard National Wildlife Refuge NPL Site
Marion, Illinois (Williamson County)

Revision 4 - Final
June 2014

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Table of Contents

List of Tables

List of Figures

List of Attachments

Acronyms and Abbreviations

AOC	Administrative Settlement Agreement and Order on Consent
AUS OU	Additional and Uncharacterized Sites Operable Unit
BERA	baseline ecological risk assessment
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	Chain of Custody
Crab Orchard	Crab Orchard National Wildlife Refuge
DI	deionized
DO	dissolved oxygen
DOI	United States Department of the Interior
DOT	Department of Transportation
DPT	direct push technology
EE/CA	Engineering Evaluation/Cost Analysis
FSP	Field Sampling Plan
FWS	United States FWS
GLS	Great Lakes Synergy Corporation
GPS	global positioning system
HHRA	human health risk assessment
HSA	hollow stemmed augers
I.D.	inner diameter
IDW	investigative derived waste
IEPA	Illinois EPA
Lake	Crab Orchard Lake
LiDAR	Light Detection and Ranging
LDPE	low-density polyethylene
LMB	large mouth bass
MS/MSDs	matrix spikes/matrix spike duplicates
NIST	National Institute of Standards and Technology
NPL	National Priorities List
ORP	oxidation/reduction potential
OSC	On Site Coordinator
PRGs	preliminary remediation goals

PTFE	Polytetrafluoroethylene
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
Refuge	Crab Orchard National Wildlife Refuge
RUSLE	revised model of the universal soil loss equation
Site	The Warehouses, the surrounding area, and any area where hazardous substances have been released, or have otherwise come to be located
SOP	Standard Operating Procedure
TOC	total organic carbon
TRC	TRC Environmental Corporation
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
VOCs	volatile organic compounds
Warehouses	Four buildings at Area 7, IN-1-3, IN-1-4, IN-1-5, and IN-1-6

Preface

On July 26, 2012 Great Lakes Synergy Corporation and the United Stated Fish and Wildlife Service entered into an Administrative Settlement Agreement and Order on Consent (AOC) for Engineering Evaluation/Cost Analysis for the matter of Crab Orchard National Wildlife Refuge, Additional & Uncharacterized Site Operable Unit, Area 7. This Field Sampling Plan has been prepared in accordance with the Work Plan (FWS, 2012) that is attached to the AOC. This Field Sampling Plan and TRC's Quality Assurance Project Plan (TRC, 2014) together comprise the Sampling and Analysis Plan required under the AOC.

Section 1 Introduction

1.1 Background

The Crab Orchard National Wildlife Refuge ("Crab Orchard" or the "Refuge"), located near Marion, Illinois, includes a site on the National Priorities List ("NPL") subject to the Comprehensive Environmental Response, Compensation, and Liability Act, as amended, 42 U.S.C. § 9601, et seq. ("CERCLA"). The Crab Orchard NPL site covers the area originally known as the Illinois Ordnance Plant during World War II. The Illinois Ordnance Plant was included within the boundaries of the Refuge when it was established by Act of Congress in 1947. The NPL site is divided into seven operable units by which the investigation and cleanup of the site is organized:

- Metals Areas Operable Unit
- PCB Areas Operable Unit
- Explosives/Munitions Manufacturing Areas Operable Unit
- Miscellaneous Areas Operable Unit – Site 14 and Site 36
- Water Towers Areas Operable Unit
- Additional and Uncharacterized Sites Operable Unit
- Lake Monitoring Operable Unit.

The Refuge is administered by the United States FWS ("FWS"). The United States Environmental Protection Agency ("USEPA"), Region 5 and the Illinois EPA ("IEPA") are support agencies for the AUS OU.

Area 7 of the AUS OU is located approximately 1.5 miles east of the intersection of Highway 148 and Ogden Road, and approximately 0.5 miles north of Ogden Road (Figure 1). Area 7 was the Illinois Ordnance Plant "inert storage" area, which consists of 26 buildings, surrounding lawns, and interconnecting roadways. All buildings within the area were labeled with an "IN" prefix to signify their location within the inert storage area.

During the 1950s to the early 1970s, Great Lakes Terminal and Transport, a predecessor company to Great Lakes Synergy Corporation (GLS), leased Buildings IN-1-3 through IN-1-6 (the "Warehouses") for storage of pesticides. The Warehouses are located in the northwest part of Area 7. The U.S. Fish and Wildlife Service (FWS) investigated the Warehouses and surrounding area as part of the Preliminary Assessment/Site Inspection (PA/SI) for the AUS OU

(URS, 2003). Additional sampling was done after the PA/SI (URS, 2002), and as part of Phase I of the Remedial Investigation (RI) for the AUS OU, in 2006-2007. Investigations included wipe sampling from building interiors and soil, groundwater, surface water and sediment samples from areas around the buildings. A drainageway leading from the Warehouses toward an embayment of Crab Orchard Lake was investigated, but samples were not obtained from the Lake. Investigation results are summarized in Section 3.2 of the Work Plan. As a result of the investigations, FWS determined that the soil adjacent to the Warehouses, the interior of the buildings, and materials inside the Warehouses, as well as the groundwater are impacted by the release and/or substantial threat of release of pesticides and other hazardous substances. Pesticides have also been detected in water and sediment samples collected from the drainageway. The Warehouses, the surrounding area, and any area where hazardous substances have been released or have otherwise come to be located is defined as the Site. As discussed in the Work Plan (FWS, 2012), an EE/CA will be conducted to address the Area 7 Pesticide Area (Site).

A preliminary baseline human health risk assessment ("HHRA") has found that the Site could pose unacceptable risks to human receptors (FWS, 2007a) and a preliminary baseline ecological risk assessment ("BERA") has found that the Site could pose unacceptable risks to ecological receptors (FWS, 2007b).

FWS has determined that a removal action is appropriate for the Site (FWS, 2009), and has developed a Work Plan to complete an Engineering Evaluation/Cost Analysis (EE/CA) in support of a non-time-critical removal action (FWS, 2012). The Work Plan document provides the general procedures and detailed directions for GLS's implementation of an EE/CA site investigation, and generation of an EE/CA Report. The Work Plan generally defines two phases of investigation. Phase I includes the collection of surface water, sediment, and fish tissue samples necessary to finalize the baseline risk assessments. The Phase II work includes the delineation of the extent of contamination.

1.2 Purpose

This Field Sampling Plan (FSP) has been prepared in accordance with the April 2012 Work Plan (FWS, 2012), and is intended to support Phase I of the EE/CA field investigation. Following the completion of the Phase I investigation, an addendum to this FSP will be prepared to define specific tasks associated with the Phase II investigation. The purpose of the FSP is to define the details of the sampling and data-gathering methods to be used during field activities. This FSP has been developed in accordance with USEPA's document titled "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA," dated October 1988.

Details of the laboratory analytical program and the specific quality assurance (QA) and quality control (QC) activities associated with data collection activities are presented in a Quality Assurance Project Plan (QAPP) (TRC, 2014).

1.3 Scope

This FSP consists of nine sections, including:

- **Section 1** describes the background, purpose, and scope of the FSP.
- **Section 2** provides a summary of the sampling program, including sample locations and frequency.
- **Section 3** covers the logistics of sample designation and field records.
- **Section 4** describes the sampling equipment and procedures for each media to be investigated.
- **Section 5** summarizes the sample handling and analytical procedures to be followed, and the specific laboratory analyses to be performed. Details regarding the sample analytical procedures are discussed in the QAPP (TRC, 2014).
- **Section 6** describes equipment and methods for performing field analyses for various chemical and physical groundwater parameters.
- **Section 7** describes field physical measurements.
- **Section 8** describes management of waste materials that will be produced during the fieldwork.
- **Section 9** is a list of references cited in this FSP.

Section 2
Summary of Sampling Program

The overall objective of the EE/CA field work program is to collect sufficient data to characterize the nature and extent of contamination including contaminant fate and transport at the Site. The field work includes collection of data to complete the baseline risk assessment (human health and ecological risks) and to address data gaps in the characterization of the site. The data gaps include detailed characterization in the vicinity of the warehouses and the Lake Embayment and Crab Orchard Lake. Data is needed to determine whether pesticides are present in Crab Orchard Lake that may pose a current or potential threat to public health, welfare, or the environment or exceed ARARs.

The field investigation for the EE/CA will be completed in two phases.

- **Phase I:** The first phase of the investigation will focus on the collection of the sediment, surface water, and fish tissue samples to delineate nature and extent, provide data for the baseline human health and ecological risk assessments, and evaluate compliance with ARARs. These data will be necessary to refine the preliminary remediation goals (PRGs) for the site, prior to performing additional characterization and delineation of soil impacts adjacent to the Warehouses. Additional investigative tasks specified in the Work Plan (FWS, 2012) that are not contingent upon the final risk assessments will be performed during the Phase I investigation wherever possible. These tasks include monitoring well installation, groundwater sampling, wipe sampling of the building interiors, initial reconnaissance of the Warehouse buildings and contents, and a topographic survey.
- **Phase II:** Phase II of the EE/CA investigation will focus on characterization and delineation (vertically and laterally) of pesticides in soil adjacent to and beneath the Warehouses as well as PAHs and VOCs in soil beneath the buildings. In addition, the Warehouse buildings will be assessed for waste disposal issues, including potential asbestos-containing material and lead-based paint, and will be assessed for vapor intrusion risk, as needed. Samples will be obtained, as appropriate for characterization for waste disposal and potential construction issues. Based on the results of the Phase I investigation, FWS may require the development of a model of fate and transport to Crab Orchard Lake, using the U.S. Department of Agriculture's revised model of the universal soil loss equation (RUSLE). If a model is required, the Phase II investigation will also include the collection of any additional data required by the RUSLE model.

This FSP is only for Phase I tasks, and will be amended for the Phase II tasks.

2.1 Pre-Sampling Site Inspection

TRC personnel will conduct a pre-sampling site inspection to gather information needed to plan the field work. The goals of the pre-sampling inspection include the following:

- Evaluate drilling and sampling locations for access issues, and determine if any brush clearing will be necessary to access the sites. Coordinate required approvals with FWS.
- Identify locations and coordinate with FWS for boat access to the embayment and to Crab Orchard Lake. Evaluate the embayment sampling locations for access on foot if inaccessible by boat.
- Evaluate the physical and hydrologic conditions of Crab Orchard Lake where sediment and surface water sampling will be conducted. Coordinate sampling locations with FWS.
- Evaluate fish tissue sampling locations to confirm habitat conditions and collection methods appropriate for target species. Coordinate required approvals with FWS.
- Discuss fieldwork logistics for remedial contractors with FWS, including items such as operating rules; facility entrance/exit locations; allowable work days/hours; set-down areas for materials; equipment decontamination pad location and central storage for investigative derived waste; access to electric power and potable water; vehicle and equipment movement within the secured area; and emergency procedures.

2.2 Pre-Mobilization Site Visit

A meeting will be held at the Refuge with representatives of FWS, TRC, and the current Warehouse tenants (as appropriate), approximately five to ten days prior to the start of any fieldwork, to accomplish the following:

- Identify and mark sampling locations, including wipe samples and monitoring well locations. Surface water and sediment sampling locations will not necessarily be marked, except as required for utility clearance.
- Receive information from FWS and current tenants regarding existing buried utilities and above-ground utilities within or in the vicinity of planned work areas. Use locator service for utility clearance.
- Confirm site conditions and access constraints prior to mobilization of subcontractors and field crews.

2.3 EE/CA Investigation – Phase I

The Phase I investigation will focus on the collection of sediment, surface water, and fish tissue samples. The Warehouse area drains to an embayment of Crab Orchard Lake that is separated from the main part of the Lake by a causeway (Figure 1 and Figure 2). The embayment and main part of the Lake are connected by several pipes that penetrate the causeway. To delineate

the nature and extent of contamination and fate and transport of contaminants released from the Site, samples of surface water, sediment, and fish will be collected from the embayment, from the Lake adjacent to the embayment, and from Crab Orchard Creek, as described in the following subsections. Table 1 presents a summary of the proposed sampling and analytical program. After the sampling results are available, FWS will assess the need for sampling of surface water, sediment, and/or fish tissue from a reference site.

2.3.1 Sediment Sampling

Sediment sampling is planned to be conducted at 26 locations within the embayment, Crab Orchard Lake, and Crab Orchard Creek, as shown in Figure 2. The exact location and number of the sediment samples will be determined in the field, based on field conditions and access. One of the sediment sampling locations will be at the mouth of the drainageway leading from Area 7. The rationale for each of the sample locations is as follows:

- Samples A through G: assess the potential contribution of pesticides from Crab Orchard Creek.
- Samples H and I: assess the potential impact from other drainages into the embayment.
- Sample J: assess potential impact from sediment accumulation.
- Sample K: assess potential for impact at the embayment outlet.
- Samples L, M, and N: assess potential impact just beyond embayment.
- Samples O, P, and Q: assess potential for impact near and just downstream of the Area 7 drainage.
- Samples R, S, T and U: assess potential for impact further downstream from the Area 7 drainage.
- Samples V, W, X, Y and Z: to provide a total of 8 samples for statistical analysis for the area of Crab Orchard Lake just outside the embayment for comparison to the fish sampling results.

At sediment sample locations A through U, a sediment core will be collected through the entire thickness of the soft sediment, or to refusal using a coring device pushed by hand into the sediment. This is based on the assumption that pesticide contamination from the Warehouses is not present at depth in the vicinity of these samples. If information suggests that the nature and extent of pesticides has not been delineated, additional deeper samples may be collected during Phase II. At sample locations V through Z, only the upper 6-inches of the sediment will be collected.

At each location, sediment samples for laboratory analysis will be collected at 6-inch intervals for the first full foot of sediment present, and at 1-foot intervals for the remaining length of the sediment column. The sample collected from the upper 6-inch interval at each location will be analyzed for pesticides and total organic carbon (TOC). The remaining samples from each core will be analyzed for pesticides. The analytical program is summarized in Table 1 and the target analyte lists for each method are included in the QAPP (TRC, 2014).

Sediment samples will be collected in accordance with field Standard Operating Procedure (SOP) SOP-0025-002 for sediment sampling which is presented in Attachment 1.

2.3.2 Surface Water Sampling

Unfiltered surface water samples will be collected at the same locations as the sediment samples (Figure 2). Each surface water sample will be submitted to the laboratory for pesticide analysis. The analytical program is summarized in Table 1 and the target analyte lists for each method are included in the QAPP (TRC, 2014). Surface water samples will be collected in accordance with the field SOP included in Attachment 1 (SOP-0025-003).

2.3.3 Fish Sampling

Fish sampling will be completed within the two areas shown on Figure 3. The specific locations will be selected in the field and approved by FWS, and will include shoreline locations. Fish sampling will be conducted during the legal fishing season on Crab Orchard Lake (March 15 to September 30) after obtaining all appropriate permits. In addition, the fish sampling will be planned to avoid the time period of approximately two to four weeks prior to, or after, the spawning season (spawning is typically between mid-April and late-June), and will not be done in the spring due to the likelihood of low lipid content of the fish.

Human Health Risk Assessment

Fish tissue samples of two game fish species will be collected and analyzed for total lipids and pesticides for the HHRA. For human health risk assessment purposes catfish fillets (no skin) and bass fillets (with skin) from the largest specimen collected above the legal size (in the event that more than the required number of fish above the legal size are collected) will be collected and analyzed for pesticides and lipids. Largemouth bass are preferred and will be collected if available. If insufficient largemouth bass are available to meet the

Work Plan requirements, other types will be used (i.e., smallmouth, striped bass, white bass and yellow bass). However, the bass used for analysis will be all of the same type (e.g., either all largemouth, all smallmouth, etc.). Eight samples of both types will each be collected from Fish Sample Area 1 and Fish Sample Area 2 (Figure 3), for a total of 32 fish samples. QA/QC analysis will be performed on the fish samples in accordance with the program summarized in Table 2. Samples selected and submitted for matrix spike/matrix spike duplicate (MS/MSD) analysis will be designated on the laboratory Chain of Custody (COC) form. The weight and body length will be determined in the field. For individual fish, necropsies for external and internal morphology and abnormalities, sex determination, collection of organ tissues for age determination and pathology, and processing of fillets for chemical analysis will either take place in the field or in a laboratory. If whole fish are to be processed in a laboratory, they will be shipped live for delivery within 24 hours of shipment. Organs including liver, spleen, gonads, and kidney will be collected from each fish for histopathology. After FWS' review of the necropsy information and the analytical results, if FWS determines that histopathology is needed, it will be conducted as instructed by FWS. Processing of fish will be conducted in accordance with field SOP-10 (Attachment 1).

Ecological Risk Assessment

Whole-body specimens of two forage fish species will be collected and analyzed for total lipids and pesticides for the BERA. Fish species will consist of bluegill and either gizzard shad, common carp, or common minnow species (the second species selected in the field depending upon species availability). Eight samples of each type will each be collected from Fish Sample Area 1 and Fish Sample Area 2 (Figure 3), for a total of 32 fish samples to be collected for chemical analysis. QA/QC analysis will be performed on the fish samples in accordance with the program summarized in Table 2. Samples selected for MS/MSD analysis will be designated on the COC form. The sex, weight, body length, and morphological abnormalities will be determined in the field, while age will be determined by a laboratory. Forage fish will be collected from both near shore and deep water locations. In addition, one sample of each species will be collected from within the embayment for necropsy, and target organ (liver, gonad, kidney, spleen) collection and preservation for potential histopathology. For individual fish in these two samples, necropsies for external and internal morphology and abnormalities, and collection of organ tissues for pathology will either take place in the field or in a laboratory. If

whole fish are to be processed in a laboratory, they will be shipped live for delivery within 24 hours of shipment.

After FWS' review of the necropsy information and the analytical results, if FWS determines that histopathology is needed, it will be conducted as instructed by FWS. Fish tissue samples will be collected in accordance with the field SOP included in Attachment 1 (SOP-10).

2.3.4 Groundwater Monitoring Well Installation

Three water table monitoring wells will be installed at the approximate locations shown on Figure 4. The purpose of the new monitoring wells is to assess the extent of exceedences of Illinois groundwater standards for 1,2,3-trichloropropane and/or 1,2-dichloropropane reported at existing wells W01, W02, and W15; and the extent of exceedences of dieldrin and/or heptachlor epoxide reported at W01 and W02. Depending on the results of the additional groundwater investigation and sampling as described for Phase I, investigation of the vertical extent of groundwater contamination may be warranted for Phase II. The groundwater monitoring wells will be installed and developed in accordance with the field SOPs included in Attachment 1 (SOP-05).

A slug test will be performed at each of the new monitoring wells following development in order to estimate the hydraulic conductivity of the formation. Monitoring well slug tests will be performed in accordance with the field SOPs included in Attachment 1 (SOP-08).

2.3.5 Groundwater Sampling

Following installation, development, and slug testing, static water levels will be collected from each of the new and existing permanent monitoring wells associated with the Area 7 pesticide area: W01, W02, W03, W15, W17, and new wells W21, W22, and W23. Groundwater samples will then be collected from each of the three new wells (W21, W22, and W23) and from five existing permanent wells (W01, W02, W03, W15, and W17), and analyzed for volatile organic compounds (VOCs) and pesticides. The analytical program is summarized in Table 1 and the target analyte lists for each method are included in the QAPP (TRC, 2014). Groundwater sampling will be conducted in accordance with the field SOPs included in Attachment 1 (SOP-06 and SOP-07).

2.3.6 Building Interior Wipe Samples/Initial Building Reconnaissance

Eight wipe samples will be collected from the interior of Building IN-1-3, in order to assess the building's suitability for use. Three of the wipe samples will be collected from

the metal walls, three will be collected from the wood frame, and two will be collected from the floor. The locations of the wipe samples will be specified in the field by FWS. Each of the wipe samples will be analyzed for pesticides. The analytical program is summarized in Table 1 and the target analyte lists for each method are included in the QAPP (TRC, 2014). Wipe sampling will be conducted in accordance with the field SOP included in Attachment 1 (ECCS-01).

The interiors of Warehouse buildings IN-1-3, IN-1-4, IN-1-5, and IN-1-6 will be examined for general contents, and assessed for the level of effort necessary to complete an asbestos and lead paint survey. The documentation of the contents of Buildings IN-1-3, IN-1-4, IN-1-5, and IN-1-6 will include sketches, photos, and estimates of volumes of materials within each building. Sampling required for characterization for waste disposal and evaluation of asbestos-containing materials and lead-based paint will be conducted during the Phase II investigation.

2.3.7 Topographic Survey

A topographic survey will be conducted of the portion of the site that has not yet been surveyed. The survey will provide the data necessary to create a base topographic map with a 2-foot contour interval. The survey will be inclusive of the watershed area for the ditch flowing north through Area 7, and as shown on Figure 5.

2.3.8 RUSLE Modeling – Initial Data Collection

The need for a transport model will not be known until the completion of the Phase I field investigation. Initial reconnaissance of the model area will be performed during the Phase I investigation in order to delineate major vegetation types within the watershed, and identify potential data gaps in the event that a model becomes necessary. Any physical or chemical data gaps that are identified will be addressed during the Phase II investigation.

2.4 EE/CA Investigation – Phase II

As described above, the scope and details of the Phase II investigation are to be defined following the completion of the Phase I investigation, and the subsequent revision of the baseline risk assessments. It is expected that the details of the Phase II investigation will be presented in an addendum to the FSP.

Section 3
Sample Designation, Control, and Field Records

Specific procedures regarding sample designation, sample control, and field records are described in detail in SOP-09, included in Attachment 1. The subsections below provide an overview of the project requirements.

3.1 Sample Designation

Samples will be assigned a unique alpha-numeric sample descriptor identifying the study area, media type, and sample location, as described in SOP-09. Example sample designations are shown in Table 1.

3.2 Chain-of-Custody Procedures

Chain of Custody (COC) procedures are presented in detail in SOP-09 (Attachment 1), which includes example COC forms. The sampler is responsible for sample custody from the time of sample collection to receipt at the laboratory or until samples are shipped by commercial carrier. A sample is considered under custody if:

- the sample is in a person's possession,
- the sample is in that person's view after being in his or her possession,
- the sample was in that person's possession and then placed in a locked secured location, or
- the sample is in a designated locked secure area.

Sets of sample containers that are shipped together will be assigned a Chain-of-Custody form, which will travel with the sample containers. A copy of the Chain-of-Custody form with its assigned sample numbers will be kept in the laboratory to help identify samples that might become separated from the discrete sample delivery group. When shipped by a commercial carrier, custody seals will be attached to each cooler to ensure that the samples are not tampered with during transit, and the shipment airbill will be kept as Chain-of-Custody documentation. A further discussion of Chain-of-Custody procedures and copies of the Chain-of-Custody forms are included in the QAPP (TRC, 2014), as well as in SOP-09 (Attachment 1 of this FSP).

3.3 Field Records

3.3.1 Purpose

This section describes requirements and procedures for documenting field activities. All fieldwork personnel will be cognizant of the requirement that all field documentation must provide a clear, unbiased description of field activities.

3.3.2 Procedures

Serially numbered field notebooks will be used on work assignments requiring field activities. Daily field activities will be recorded in bound field notebooks. Field data forms shall be used to document sampling information for water level data, groundwater sampling, surface water sampling, sediment sampling, soil sampling, and geologic logging. Fish data forms will be prepared for each fish necropsied and from which tissues are collected for histopathology or chemical analysis. Representative forms are provided in Attachment 2. The information recorded in the field logbook and/or the field data forms will include the following:

- Site personnel present;
- Time and date;
- Equipment calibration activities undertaken and results;
- Weather conditions;
- Type of work being performed and location of the work;
- Type of equipment used;
- Time of day tasks were begun and completed;
- Any pertinent observations or description of unusual conditions;
- Difficulties or problems encountered;
- Description actions taken or direction given to resolve a situation;
- Deviations from approved documents;
- Results of inspection activities;
- Contractors, subcontractors, and government agencies present on site;
- Decontamination activities;
- Any other relevant or pertinent comments related to field work; and
- Level of protection.

The TRC Environmental Corporation (TRC) On Site Coordinator (OSC) will distribute and track bound and numbered field notebooks. Transfers of field notebooks to other individuals (including subcontractors) who have been designated to document specific tasks on the project will be recorded. No field notes may be destroyed or discarded, even if they are illegible, or known to contain inaccuracies. All field records will be scanned on a weekly basis and included in the Appendices to the EE/CA Report.

Entries into field notebooks will be legibly written and will provide a clear record of field activities. Entries will be made in waterproof ink, in language that is objective, factual, and generally free of personal opinions, or terminology that might later prove unclear or ambiguous. Errors in the field notes will be indicated by drawing a single line through the text, such that the text in error remains legible. Errors addressed in this manner will be initialed by the person making the correction. The person taking notes in the fieldbook will sign and date each page and will identify the date, the time, the location on-site, the field personnel present, and the weather conditions observed.

Use of measurements and readings from on-site health and safety equipment will be recorded. Observed potential hazards to health and safety will be described. The level of protection and the decontamination procedures will be documented.

3.4 Photographs

Photographs will be used to document sample locations and site conditions, including the condition of the Warehouse buildings. Refer to SOP-03, SOP-04, SOP-10, and SOP-0025-002 for specific requirements for field photographs. Photographs will be documented in the field notebook at the time the photograph is taken. An electronic color copy of each photograph will be made and labeled with the following information:

- Project identification number
- Date
- Location
- Name of person taking photograph
- Direction viewed in photograph
- Brief description of what is contained in the photograph

Photographic documentation will be used to record the necropsies. Abnormal tissues designated by the pathologist will be photographed, as will several normal tissues for photographic comparison to abnormal tissues. Photographic documentation will be conducted using a digital camera, and each photograph will be taken against a solid color background

sheet with a sample identification label clearly visible in the photograph. The removable storage device will be changed daily and sequentially numbered (month, day, unique identification number). Removable storage devices will be archived as original data.

Removable storage devices containing the photographs in a JPEG format will be included with the EE/CA report.

Section 4
Sampling Equipment and Procedures

This section describes the equipment to be used and the procedures to be followed for collecting samples in the field. Samples will be collected to obtain a representative portion of the matrix being sampled. Valid and reliable results depend on the following:

- Obtaining samples that are as representative as possible of the matrix being sampled
- Using proper sample collection, handling, and preservation techniques
- Identifying the collected samples and documenting their collection in permanent field records (Subsection 3.3.2)
- Maintaining sample Chain-of-Custody procedures (Subsection 3.2)
- Protecting the collected samples by properly packing, preserving, and transporting them to the FWS approved laboratory for analysis

Deviations from the procedures specified in the FSP will be documented in the bound field notebooks and the corrective action procedures from QAPP Worksheet #14 will be implemented. Any deviations will be reported immediately to the FWS Project Manager or designee. Requests for changes in procedures will be made to the FWS Project Manager or designee, and changes will not be implemented without the approval of the FWS Project Manager or designee. If necessary, corrective actions will be implemented and will follow procedures described in QAPP Worksheets #6, #14, #31-1, and #32-1 (TRC, 2014).

4.1 General Considerations

The following factors and procedures are general considerations to be used in planning and performing sampling. These factors and procedures will be considered with respect to the specific objectives and scope of the field investigation, as presented in this FSP and the QAPP:

- Safety of sampling personnel
- Coordination of access with FWS and property tenants
- Fish sampling is restricted to the legal fishing season
- Procedures for identifying potentially hazardous samples
- Collection of auxiliary data
- TRC will ensure that utility clearance is completed before any intrusive work begins. Utility clearance will be conducted via Illinois' one-call system (JULIE), and by local utilities not participating in the one-call service, or by a local contractor.

4.2 Decontamination Procedures

Decontamination procedures for drill rigs and drilling equipment that is brought on site is described in detail in SOP-01 (Attachment 1). Decontamination procedures for field equipment is described in detail in SOP-02 (Attachment 1).

4.2.1 Single-Use Sampling Equipment

To the extent practicable, single-use or dedicated sampling equipment and materials will be used for the collection of samples. The materials used will be new and clean, and will be placed in clean, unused plastic for transport to the site. Once used, single-use equipment will be placed in plastic bags and managed as investigation-derived waste material. Dedicated equipment will remain in the wells, or sealed in clean plastic bags for storage. Single-use equipment includes, but is not limited to, the following:

- Polytetrafluoroethylene (PTFE)-lined low-density polyethylene (LDPE), PTFE, and/or silicon tubing
- Aluminum or stainless steel core barrels
- Nylon rope
- Disposable bailers

4.2.2 Non-dedicated Sampling Equipment

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Non-dedicated equipment used for purging and sampling monitoring wells and sampling surface water or sediment will be cleaned before its initial use in the field and again before use at each subsequent sampling location and between intervals for sediment and soil sampling events. Equipment subject to this decontamination procedure includes, but is not limited to, the following:

- Submersible pumps
- Water level indicator
- Flow through cell
- Field parameter probes
- Piston core sampler, Russian peat corer, Wildco sampler, or equivalent
- Stainless steel scoops and bowls

Non-dedicated sampling equipment will be new, or will be decontaminated at TRC prior to its initial use on-site and in between sampling points. Decontamination will be performed in accordance with SOP-02 (Attachment 1).

Field decontamination will take place at the sampling location, or at a temporary decontamination pad set up for drilling equipment. Decontamination fluids will be managed in accordance with SOP-11.

When field-cleaning of sampling equipment is required, a piece of the field-cleaned equipment will be selected for collection of a field equipment blank sample. After the piece of sampling equipment has been field-cleaned, and prior to its use for sampling, it will be rinsed with organic free water. The rinse water will be collected and submitted for analysis of all constituents for which the normal samples collected with the equipment are being analyzed. The frequency of blank collection and the analytical program for the blanks are summarized in Table 2.

4.2.3 Non-dedicated Fish Dissecting Equipment

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Non-dedicated equipment used for fish necropsy and tissue collection will be cleaned before its initial use in the field and again as required by the Fish Sampling SOP (SOP-10). At a minimum, non-dedicated fish dissecting equipment will be decontaminated after each individual fish is processed. Decontamination will be performed in accordance with SOP-12.

Field decontamination will take place at the fish processing location, or at a temporary decontamination station set up for fish dissecting and sampling equipment. Decontamination fluids will be managed in accordance with SOP-11.

When field-cleaning of dissecting and sampling equipment is required, a piece of the field-cleaned equipment will be selected for collection of a field equipment blank sample. After the piece of sampling equipment has been field-cleaned, and prior to its use for fish necropsy or tissue collection, it will be rinsed with organic free water. The rinse water will be collected and submitted for analysis of all constituents for which the normal samples collected with the equipment are being analyzed. Rinsate samples will be collected at a rate of one every 20 samples, with at least one rinsate sample being collected every day.

4.3 Surface Water and Sediment Sampling

The collection of sediment samples will be paired with the collection of surface water samples, as discussed in Section 2. Sediment and surface water samples will be collected at each of the 26 sample locations, as described in Section 2, if the sample locations can be reasonably and safely accessible by a jon boat (or equivalent) or on foot. If the proposed sample location cannot be sampled due to one or

more access requirements as described above, FWS will be notified, and alternate sediment sample locations will be discussed.

The detailed procedures for the sampling of surface water and sediment are found in SOP-0025-003 and SOP-0025-002, respectively (Attachment 1). Surface water and sediment samples will be collected from downstream locations to upstream locations, in order to minimize potential impact from sediment disturbed during sampling activities. In addition, at locations where both sediment and surface water samples are to be collected, the surface water sample will be collected prior to the sediment sample.

4.3.1 Field Locations

Each of the surface water and sediment sampling locations will be located and marked in the field using a differential global positioning system (GPS) unit programed with the sampling locations discussed in Section 2. These pre-determined locations were selected as targets based on the rationale discussed in Subsection 2.3. The sediment sample will be collected at the pre-determined location. If present at the pre-determined location, the sediment sample will be collected from depositional features and/or soft sediment at/or in close proximity to the predetermined locations. The depositional feature and/or soft sediment will be identified in the field using visual observation and/or sediment probing. The final location of each sediment or surface water sample will be photographed and recorded using a hand held GPS unit (with sub-foot to sub-meter accuracy).

4.3.2 Surface Water Sampling

Surface water samples will be collected from a jon boat (or equivalent) whenever possible, in order to avoid disturbance of the sediment surface by wading personnel. At each location, the water depth will be measured using a weighted measuring tape or calibrated rod. The water depth will be recorded in the field logbook.

Surface water samples will be collected in accordance with SOP-0025-003, including the FWS addendum dated April 29, 2010, as modified by TRC on June 28, 2013 (Attachment 1).

Pump tubing and other general waste materials generated by the surface water sampling will be collected and managed as investigation-derived waste materials as specified in SOP-11.

4.3.3 Sediment Sampling

Sediment samples will be collected using a coring device (e.g., piston core sampler, Russian peat corer, or Wildco sampler) wherever possible. The type of sampler selected for use will depend on the type of sediment present, the depth of standing water over the sample location, and the expected thickness of sediment. Since the target thickness of the sediment samples at most locations (48-inches) exceeds the barrel length of the Russian peat corer and Wildco sampler (20-inches), the piston core sampler will be the primary sediment sampling tool used within Crab Orchard Lake, and the embayment (where water is present).

Sediment samples will be collected in accordance with SOP-0025-002, including the FWS addendum dated April 29, 2010, as modified by TRC on June 28, 2013 (Attachment 1).

Excess sediment material and general waste materials generated by the sediment sampling will be collected and managed as investigation-derived waste materials as specified in SOP-11.

4.4 Fish Sampling

As presented in Section 2, fish tissue samples will be collected from the areas delineated on Figure 3. Two species of game fish will be sampled for the HHRA, and two species of forage fish will be sampled for the BERA. Fish tissue samples will be collected in accordance with field SOP included in Attachment 1 (SOP-10). A general discussion of the fish sampling approach is described in the following subsections.

4.4.1 Game Fish Sampling

Two species of game fish will be collected for tissue analysis. The target species are bass and catfish. Largemouth bass shall be 16-inches or longer. No legal limit has been established for other bass species or catfish. Sixteen game fish samples of each species will be collected; eight from "Fish Sample Area 1" in Crab Orchard Lake, and eight from "Fish Sample Area 2" in the embayment (Figure 3).

Game fish will be sampled from open/deeper water location(s) in Areas 1 and 2. Efforts will be made to collect fish throughout the sampling area at locations agreed upon with FWS. If fish are not able to be collected throughout the sampling area, multiple fish, comprising multiple fish samples, may be collected from a single sampling location, depending on the abundance and/or availability of a fish species with approval from FWS. There may be some sampling locations where no sample is collected due to the absence of fish meeting the criteria. The sampling location of each fish sample will be noted in the field and on the COC. The specific locations will be selected at the time of sampling based on the field/water conditions on the day of sampling. The coordinates

of each sampling location will be determined by a GPS recorder capable of attaining a location to within one meter. The coordinates of each location will be logged in the field notebook.

Game fish will be sampled using electrofishing, gill-netting, or via line sampling (trotline or angling). All fish collected from a sampling location will be identified, and externally examined. Target species will be retained and non-target species will be released. All fish captured at a sampling location will be placed in a wet well. For electrofishing, and line sampling, fish should be processed immediately upon completion of each station. For fish not retained for sampling, the maximum hold time would be one hour. For a live well with continuous water exchange, or if the live well is in the embayment, fish to be retained as a potential sample may be held until the end of a given sampling day, provided that the fish are monitored and are not excessively stressed (e.g., by remaining continuously in hot sun). Target species will be retained and non-target species will be released. All collecting effort notes and observations will be recorded in a field notebook.

Each fish retained will be processed in accordance with Site Specific Standard Operating Procedure (SOP) 10, Fish Sampling Crab Orchard National Wildlife Refuge. As required by this SOP, each fish retained will be tagged with a unique identification number and measurements and observations for each fish will be recorded on a Fish Data Form. Species identification, weight and length measurements will be made in the field. Necropsies for external and internal morphologies and abnormalities, sex determination, collection of organs for histopathology and processing of tissues for age determination and chemical analysis will be performed either in the field or at an off-site laboratory. If necropsies and tissue collection are to be performed off-site, fish will be shipped live for over-night delivery. Aging analysis will be performed at an off-site laboratory. Chemical analysis of catfish and largemouth bass fillets will be performed at an off-site laboratory. Chain-of-custody forms will accompany all samples shipped from the field to the laboratory where the samples will be processed and from the processing laboratory to the analytical laboratory.

Histopathology will be completed on the preserved sample organs selected by FWS after FWS's review of the necropsy and pesticide analytical results.

4.4.2 Forage Fish Sampling

Two species of forage fish will be collected for tissue analysis. The target species are bluegill and another forage fish species, such as gizzard shad, common carp, or other locally abundant forage fish species. Forage fish shall be a maximum of 10-inches and a

minimum 4-inches in length. However, smaller fish may be selected if 4-inch or larger forage fish are not available, and if approved by the FWS. Sixteen samples of each forage fish species will be collected; eight from "Fish Sample Area 1" in Crab Orchard Lake, and eight from "Fish Sample Area 2" in the embayment (Figure 3). One additional sample of each forage fish species will be collected from the embayment for necropsy and potential tissue histopathology.

Sampling of forage fish will be attempted from both from near shore and open/deeper water locations in Areas 1 and 2. Efforts will be made to collect fish throughout the sampling area at locations agreed upon with FWS. If fish are not able to be collected throughout the sampling area, multiple fish, comprising multiple fish samples, may be collected from a single sampling location, depending on the abundance and/or availability of a fish species with approval from FWS. There may be some sampling locations where no sample is collected due to the absence of fish meeting the criteria. The specific locations will be selected at the time of sampling based on the field/water conditions on the day of sampling, and the final locations will be recorded with a GPS and logged in the field notebook. The forage fish sampling locations in deep water may coincide with the game fish locations, but separate locations for forage fish will be added to include the near shore areas.

Sampling methods for forage fish may include seining, gill-netting and electrofishing, and will depend on the physical environment of the sampling location. At each fish sampling location the sampling method will depend on habitat characteristics, such as water depth and sediment substrate. In deeper water, a crew of two sampling team members will operate the sampling equipment (i.e., boat and electrofishing equipment). The third sampling team member will use a dip net to capture fish. In shallow water, crew members will employ a seine to capture fish. At all sampling locations, one team member will be the designated recorder and will make entries into the field notebook. All fish captured at a sampling location will be placed in a wet well or bucket of water. Fish should be processed immediately upon completion of each station. For fish not retained for sampling, the maximum hold time would be one hour. For a live well with continuous water exchange, or if the live well is in the embayment, fish to be retained as a potential sample may be held until the end of a given sampling day, provided that the fish are monitored and are not excessively stressed (e.g., by remaining continuously in hot sun). Target species will be retained and non-target species will be released.

Each fish retained processed in accordance with Site Specific Standard Operating Procedure (SOP) 10, Fish Sampling Crab Orchard National Wildlife Refuge. As required by this SOP, each fish retained will be tagged with a unique identification number and

measurements and observations for each fish will be recorded on a Fish Data Form (Attachment 2). Species identification, weight and length measurements, examination for morphologic abnormalities, and sex determination will be made in the field while age will be determined in the laboratory. Fish selected for pesticide analysis will be euthanized, and individually wrapped in aluminum foil shiny side out and placed in a sealable clean plastic bag, with the bag pre-labeled with the appropriate sample designation (see Subsection 3.1) to identify the sampling location, matrix, and species. A forage fish sample for tissue analysis may be a composite of two or more fish of approximately the same size and of sufficient mass to yield a minimum 20 gram sample required for pesticide analysis. Each sample will then be placed in a second bag. All bagged whole fish samples for pesticide and lipid analysis will be placed in an ice filled cooler and shipped overnight to the laboratory for preparation and analysis. A chain-of-custody (COC) form will accompany each shipment of fish. It is not anticipated that forage fish samples will need to be shipped from laboratory to laboratory; however, in the event that a transfer occurs between laboratories, the COC forms will accompany subsequent sample shipments.

One sample of each forage fish species will be collected from within the embayment for sexing, necropsy and histopathology. After tagging, species determination, weighing and measuring, fish selected for sex determination, necropsy for external and internal morphology and abnormalities, and histopathology will be processed either in the field or in an off-site laboratory. If necropsies and tissue collection are to be performed off-site, fish will be shipped live for delivery within 24 hours of shipment. Aging analysis will be performed at an off-site laboratory. Chain-of-custody forms will accompany all samples shipped from the field to the laboratory where the sample will be processed. It is not anticipated that forage fish samples will need to be shipped from laboratory to laboratory; however, in the event that a transfer occurs between laboratories, the COC forms will accompany subsequent sample shipments.

Histopathology will be completed on the preserved sample organs selected by FWS after FWS's review of the necropsy and pesticide analytical results.

4.4.3 Agency Oversight and Field Communication

The FWS will provide a fisheries biologist as a representative on site at the start of the fish sampling to help identify sampling locations and field-verify the sampling effort and results. While every effort will be made to collect the desired species and sample sizes to meet the fish sampling requirements defined in the Work Plan, TRC cannot guarantee that the collection efforts will be completely successful. TRC will communicate results to FWS while in the field, such that FWS and TRC will discuss

options to continue sampling, discontinue additional sampling efforts, or collect smaller fish if smaller fish of the specified species are available. If smaller fish are collected, compositing may be necessary to obtain the minimum of 20 grams needed for laboratory analysis for pesticides. All collecting effort notes and observations will be recorded in a field notebook.

4.5 Groundwater Monitoring Well Construction and Development

Details regarding the installation of soil borings, monitoring well construction (including material specifications), and monitoring well development are contained in SOP-03, SOP-04, and SOP-05 (Attachment 1). Three additional monitoring wells will be installed. Based on existing monitoring well data, each borehole is expected to be advanced to an approximate depth of 17 to 20 feet below ground surface (bgs). The final location and elevation of the wells will be surveyed by a Professional Land Surveyor in accordance with the land survey methods identified in Section 7. The elevation of the top of each well casing will be surveyed to within 0.01 feet, and the ground surface elevation will be surveyed to within 0.1 feet. Additional survey requirements for monitoring wells are included in SOP-05. Soil cuttings, fluids, and other waste materials generated by the work will be managed in accordance with SOP-11.

4.6 Groundwater Sampling

The detailed procedures for the collection of groundwater samples are included in SOP-07 (Attachment 1). Groundwater samples will be collected from the least impacted well to most impacted well, based on data collected during the RI/FS. Waste fluids (including, but not limited to groundwater from purging), single use sampling devices and equipment, and other general waste materials generated during sampling will be collected and managed in accordance with SOP-11.

4.7 Single Well Response Tests

Single well response tests will be conducted on each of the three new monitoring wells following development, in order to estimate the hydraulic conductivity of the formation around the well screens. Hydraulic conductivity tests will be performed in accordance with SOP-8.

4.8 Wipe Samples of Building Interior

Wipe samples will be collected from 8 locations within Warehouse building IN-1-3 at locations to be determined by FWS. Each sample will be collected in accordance with ECCS-01 (Attachment 1) and ASTM D6661-10, and as described below:

- Select the surface to be sampled. It should be a relatively flat and smooth surface that can be easily and thoroughly wiped with a gauze pad. The sample area will be 100 cm^2, and will be marked with a template prior to sampling.
- Prepare a 3-inch by 3-inch gauze pad by moistening with 80/20 iso-octane/acetone using a Pasteur pipette (do not soak).
- Thoroughly wipe the sample area with the gauze pad. Take care to ensure that the pad does not come in contact with any other surface.
- Fold over the gauze pad with the wipe surface to the inside, and insert into the sample jar.
- Place the sample containers on ice immediately following sample collection.

4.9 Sampling QA Procedures

4.9.1 General

The sample collection procedures presented in this FSP (which includes all attachments) are designed to provide samples of the required quality for completion of the risk assessments and to delineate the nature and extent of contamination. All field personnel will be required to understand the requirements of this FSP and will be trained in the use of the specified equipment and techniques.

The TRC On Site Coordinator (OSC) is responsible for reviewing the day-to-day activities to ensure that the procedures in the FSP are followed. Specific activities that will be implemented by TRC include the following:

- Convene a meeting of field personnel at the start of a specific sampling event to review the sampling requirements of the FSP, review the necessary equipment and decontamination requirements and use, and review the required documentation (health and safety issues will also be covered).
- Review all documentation on a daily basis for completeness, errors, problems, and corrective actions taken.
- Convene daily project team meetings at the start of the day to address any problems developed during the previous day's work, and to review the work to be completed that day.
- Manage the implementation of in-field corrective actions in accordance with QAPP Worksheets #6, #14, #31-1, and #32-1. The TRC Project Manager will be notified of significant problems and, if necessary, will work with the TRC OSC to develop corrective actions. The project manager will be responsible for implementing corrective actions that need to be applied to areas other than field activities.

4.9.2 Sample Collection

Personnel involved in the collection of samples are required to read, understand, and follow the procedures specified in this FSP. Problems that may affect the quality of the sampling effort will be recorded by the field personnel most directly involved with the problem, and the OSC will be notified and responsible for coordinating the development and implementation of corrective actions with the TRC Project Manager (QAPP Worksheets #6, #14, #31-1, and #32-1).

4.9.3 Analytical Quality Assurance Considerations

Analytical quality control samples are discussed in detail in SOP-09. Table 2 summarizes the field quality control samples to be collected as a part of the EE/CA investigation. This information is also included in QAPP Worksheet #20.

Section 5
Sample Handling and Analysis

5.1 Sample Containers and Shipping

Sample containers, preservation methods, and holding times that meet USEPA standards for solid, liquid, and tissue samples intended for chemical analyses are summarized in the QAPP (TRC, 2014), and have been included in this FSP in Table 3. For samples intended for VOC analysis, the sample containers will be filled completely to minimize airspace.

The OSC will be responsible for the proper use of containers and preservatives. Procedures for sample shipping and other sample management are included in SOP-9.

5.2 Selection of Parameters for Analysis

The samples to be collected for this EE/CA Phase I investigation will be analyzed for the parameters noted in Table 1.

5.3 Laboratory Analytical Procedures

The selection of analytical procedures will reflect USEPA-approved methodology from the Contract Laboratory Program (CLP) Statements of Work, SW-846, and EPA 600 Methods, where applicable, as stated in the QAPP. Other methods designed to meet project-specific objectives are also defined in the QAPP.

Section 6
Field Analyses

Field analytical measurements to be taken during the fieldwork program will use equipment that is suitable for the analytical method to be used and is properly calibrated. The equipment used for in-field measurement will be maintained, calibrated, and used in the field according to the procedures described in this section. The process will be documented, and the OSC will periodically review the documentation and inspect the equipment to ensure that the procedures are followed by the personnel collecting the samples. Deviations from the FSP, errors, equipment failures, or other problems will be recorded in a bound notebook by the OSC and reported to the TRC Project Manager. Corrective actions and additional notifications will be coordinated by the Project Manager (QAPP Worksheets #6, #14, #31-1, and #32-1).

6.1 Calibration and Measurement

A YSI 556 flow-through cell (or equivalent) equipped with temperature, specific conductance, pH, DO, and ORP electrodes will be used to collect field water quality measurements for surface water and groundwater samples. Refer to SOPs -05, -07, 0025-002, and 0025-003 for information regarding the collection of these measurements. The electrodes will be placed in the flow-through cell on the discharge from the submersible pump. Turbidity measurements will be made with a Hach Model 2100P turbidity meter (or equivalent) using water from the pump discharge, prior to entering the flow-through cell.

The equipment will be checked for any mechanical or electrical failures, weak batteries, and cracked or fouled electrodes before mobilizing for field activities. Calibrations and repairs will be recorded in a bound notebook with the date and the name of the person making repairs/calibrations. The equipment will be calibrated prior to use each day it is in use, and a calibration check will performed at the end of each sampling day. Additional calibrations and/or calibration checks may be performed throughout the day at the sampler's discretion.

6.1.1 pH

The pH measurements will be made using a YSI 556 pH meter and probe with its compatible YSI flow-through cell (or equivalent). The pH probe will be calibrated utilizing pH 4 and pH 7 buffer solutions. The pH of each sample will be measured in the flow-through cell. The pH measurements will be recorded to the nearest 0.1 pH unit. The meter will be calibrated and operated according to procedures outlined in the operations manual.

6.1.2 Specific Conductance

The specific conductance probe will be calibrated to a stock calibration solution. The calibration must be within 10 percent of the calibration value of the solution. Specific conductance sample measurements will be made in the flow-through cell, and are automatically corrected by the instrument to 25°C. Measurements will be reported in µmhos/cm. The meter will be calibrated and operated according to procedures outlined in the operations manual.

6.1.3 Temperature

The temperature probe will be checked prior to field activities against a National Institute of Standards and Technology (NIST)–certified thermometer. Temperature will be measured to the nearest 0.1°C within the flow-through cell. Temperature measurements are utilized directly by the instrument to correct the specific conductance reading. The meter will be operated according to procedures outlined in the operations manual.

6.1.4 Dissolved Oxygen

Dissolved oxygen will be measured in the field using a YSI 556 meter and dissolved oxygen probe (or equivalent). The meter will be calibrated and operated according to procedures outlined in the operations manual.

6.1.5 Oxidation-Reduction Potential

Oxidation-reduction potential (ORP) will be measured in the field using a YSI 556 meter and ORP probe (or equivalent). The meter will be calibrated and operated according to procedures outlined in the operations manual.

Section 7
Field Physical Measurements

Field measurements of groundwater elevations and sampling locations will be required during the fieldwork program. The measurements will be traceable to the person making the measurement and to the specific piece of field equipment used to make each measurement. Equipment maintenance and calibration records will be kept in a bound field notebook, making all such procedures traceable. Time records will be kept using local time in the 2400-hour military format.

7.1 Groundwater Levels

Groundwater levels will be measured in accordance with the procedures in SOP-06. Groundwater level measuring devices will be calibrated to 0.01-foot accuracy prior to the fieldwork. Before use, these devices are prepared according to the manufacturer's instructions (if appropriate) and checked for visual damage or defects. The manufacturer will supply documentation of calibration for each transducer.

7.2 Global Positioning System Surveying Methods

The proposed locations of monitoring wells and surface water/sediment sampling locations will be delineated in the field using a Trimble Geoexplorer 6000 Series handheld GPS unit with the proposed locations pre-loaded onto it. The GPS unit will have real-time automatic Integrated SBAS correction enabled during point location navigation. The final sampling locations will be coordinated with FWS.

The final locations of off-shore sediment, surface water, and fish tissue samples will be collected using differential GPS techniques. A Trimble Geoexplorer 6000 Series handheld GPS unit, with H-Star technology enabled, will be used to collect these locations. Where field conditions permit carrier phase GPS signal data will be used for GPS data collection. When collecting GPS location data, field staff will continuously log a sample position until the predicted post-processed accuracy is better than 1 foot. If this level of accuracy cannot be achieved, a minimum of 60 positions will be logged at that point location. Data collection times, horizontal and vertical precision, dilution of precision (DOP), standard deviation, coordinates, and field notes will be stored in the GPS datafile, and can be made available to FWS upon request. All data collected with the Trimble GPS unit will be post-processed through the software program Trimble Pathfinder Office. Data from a nearby reference station providing GPS and GLONASS reference data will be downloaded and used to differentially correct all GPS data collected in

the field. Final, post-processed GPS data files will be made available to FWS upon request. GPS and survey data will be combined into a single feature class in an ArcGIS geodatabase, which will be projected into the State Plane Illinois East coordinate system (NAD83, US Feet). GIS data will be provided to FWS in geodatabase or ArcGIS shapefile format.

GPS locations will also be collected at the final sampling location of land-based samples as a quality check that samples were collected at the proposed locations. If a sample location is moved from a proposed location due to field conditions, and in agreement with FWS, the move will be noted in the field logbook. Any data points collected with the GPS for land-based features will be replaced with data provided by the certified surveyor, where collected, upon transmittal of survey data to TRC.

7.3 Land Surveying Methods

Control points that may be required will be established by a professional licensed Land Surveyor. Location coordinates for control points will be established based on the existing coordinate system for Area 7 of the AUS OU. An accuracy of ± 0.1 foot will be provided for sampling locations.

Accurate, complete, and informative field notes for the surveying data will be prepared. The field notes will be prepared using indelible ink and will accomplish the following:

- Provide adequate and complete information that can be understood by someone other than the note taker.
- Provide documentation of the work completed or the data gathered.

The surveyor will be required to use notebook space liberally in recording necessary data. Explanatory remarks and field sketches will be included, where appropriate, to clarify the field procedures and provide added details. Two important aspects of each survey to be addressed in the field notes are as follows:

- **Starting and ending basis of the survey** - The surveyor will explain and document the starting and ending points of their survey. This applies to both horizontal and vertical control. This will require a paragraph of explanation, and sketches and/or cross-references to data in notes of previous surveys, if appropriate.
- **Clear indication of final results and checking procedures** - The final results and checks will be plainly indicated. Erasures will not be used, as they raise uncertainties about the reliability of the data. Alterations, additions, revisions, reductions, or comments added to field notes after completion of the fieldwork will be written in colored ink to indicate that such information is not part of the original field record. The person making such notations will initial and date each page so affected.

All land based sample locations and wells will be surveyed and certified by a professional land surveyor. All spatial data will be delivered in ESRI ArcView shape files. The files must define a point, line, or area, according to the most appropriate data type for the entity being represented. The shape file will contain a metadata text file and legend (.avl). The horizontal data will be reported using the horizontal data system of Universal Transverse Mercator, Zone 16, NAD 83, in meters.

7.4 Aerial Survey Methods

A high-accuracy topographic survey of the site and necessary surrounding area will be obtained as needed to prepare the site topographic map with a 2-foot contour interval. This topographic data will be collected using aerial-based Light Detection and Ranging (LiDAR) system by a licensed surveyor with appropriate equipment. If LiDAR topographic survey data becomes publically available through the state of Illinois for the Site, this data may be used as the data source for the aerial survey. The data collected will be processed to provide a detailed model of the bare earth surface, sufficient for the terrain modeling that will be conducted. Additional topographic ground survey locations will be collected to verify the LiDAR data. High-resolution orthophotography for the site will also be obtained as needed.

7.5 Elevation Datum

Benchmarks of known and reliable elevation will only be used. If no benchmark is located in the vicinity of the work where needed, an arbitrary temporary benchmark will be established on a permanent location (e.g., foundation or corner post). The locations of benchmarks utilized will be shown on a site map. Elevation surveys for temporary benchmarks will be conducted to form a circuit (i.e., the survey line will be closed back to a known benchmark). Third-order accuracy will be obtained on level circuits.

Each land-based sample location and monitoring well will be surveyed by a Professional Land Surveyor. An accuracy of ± 0.1 foot will be provided for ground surface elevations, and an accuracy of ± 0.01 foot will be provided for monitoring well casing elevations. The elevation data will be reported in feet based on the GRS-80 ellipsoid.

Section 8
Management of Waste Materials From Fieldwork Program

Investigation derived waste (IDW) streams generated during this investigation are expected to include soil cuttings and sediment, purged groundwater, decontamination fluids, and general refuse (e.g., used personal protective equipment, trash). Each waste stream will be handled in accordance with SOP-11 (Attachment 1).

Used personal protective equipment and other types of general uncontaminated debris or waste materials produced during the fieldwork will be collected daily in sealed plastic bags, and placed in a waste dumpster that will be brought to the site for the project. The waste materials will be disposed by a local commercial disposal contractor at the end of the fieldwork.

Section 9
References

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Table 1
Sampling and Analytical Program Summary
EE/CA Investigation - Phase I
Area 7 of the AUS OU - Crab Orchard National Wildlife Refuge NPL

TASK ITEM	SUMMARY	ANALYSIS/METHOD	ANALYTICAL LABORATORY [SOP REFERENCE]	EXAMPLE SAMPLE DESIGNATION
Building Interior - Wipe Samples	Building IN-1-3 with 3"x3"-gauze pad: (2) samples from floor (3) samples from metal wall (3) samples from wood frame. [ECCS-01]	Pesticides TAL/(SW846 8081A)	ECCS [ECCS-LAM-003]	"AUS-PEST-001-WI-IN13-FLR" (Bldg. IN-1-3 floor) "AUS-PEST-003-WI-IN13-WALL" (Bldg. IN-1-3 wall) "AUS-PEST-006-WI-IN13-FRM" (Bldg. IN-1-3 frame) [see SOP-09]
Sediment Sampling	Sediment samples at 21 locations (A - U) through thickness of soft sediment, or to refusal using a hand-driven coring device; sample intervals of 0.5 ft for top 1 ft of sediment; 1 ft intervals to total depth. [SOP-0025-002]	Pesticides TAL/(SW846 8081A); add TOC to uppermost interval (0.0-0.5 ft)/(Walkley Black)	ECCS [ECCS-LAM-003] ECCS (subcontract to Pace Analytical) [PACE-01]	"AUS-PEST-00A-SD-000005" (0 to 0.5' sample) "AUS-PEST-00A-SD-005010" (0.5 to 1.0' sample) [see SOP-09]
	Sediment samples at 5 additional locations (V - Z), 0.0 to 0.5 ft interval only. [SOP-0025-002]	Pesticides TAL/(SW846 8081A); TOC/(Walkley Black)	ECCS [ECCS-LAM-003] ECCS (subcontract to Pace Analytical) [PACE-01]	
Surface Water Sampling	Collect unfiltered surface water samples at locations coincident with sediment sample locations (26 locations). [SOP-0025-003]	Pesticides TAL/(SW846 8081A)	ECCS [ECCS-LAM-003]	"AUS-PEST-00A-SW" [see SOP-09]
Fish Sampling - HHRA	(8) Catfish fillets (no skin) and (8) Bass fillets from embayment. [SOP-10]	Pesticides TAL/(SW846 8081B); lipids; morphological assessment; necropsy (all); Histopathology (TBD by FWS)	ALS [ALS-SOC-8081] ALS [ALS-EXT-LIPID] SOP-10	"AUS-PEST-001-BI-LMB" (largemouth bass) "AUS-PEST-001-BI-CAT" (catfish) [see SOP-09]
	(8) Catfish fillets (no skin) and (8) Bass fillets from Crab Orchard Lake outside of embayment. [SOP-10]			
Fish Sampling - Eco Risk	(8) Specimens of each of two forage fish species, bluegill, plus either gizzard shad, common carp, or common minnow from the embayment. [SOP-10]	Pesticides TAL/(SW846 8081B); lipids; morphological assessment (all)	ALS [ALS-SOC-8081] ALS [ALS-EXT-LIPID] SOP-10	"AUS-PEST-001-BI-BLU" (bluegill) [see SOP-09]
	(8) Specimens of each of two forage fish species, bluegill, plus either gizzard shad, common carp, or common minnow from Crab Orchard Lake outside the embayment. [SOP-10]			
	(1) Specimen of two forage fish species (same species as selected for pesticide analysis) from the embayment. [SOP-10]	Necropsy; Histopathology (TBD by FWS)	SOP-10	
Groundwater Sampling	Collect groundwater samples from (5) existing and (3) new monitoring wells. [SOP-06, SOP-07]	Pesticides TAL/(SW846 8081A); VOCs TAL/(SW846 8260B)	ECCS [ECCS-LAM-003] ECCS (ECCS-LAM-004]	"AUS-PEST-W03-GW" [see SOP-09]

Notes:
TAL = Target Analyte List. The TALs for each analytical group are included in the QAPP (TRC, 2013).
TOC = Total Organic Carbon.
VOC = Volatile Organic Compounds.

Table 2
Field Quality Control Sample Summary
EE/CA Investigation – Phase I and Phase II
Area 7 of the AUS OU – Crab Orchard National Wildlife Refuge NPL

MATRIX	ANALYTICAL GROUP	NUMBER OF SAMPLING LOCATIONS[1]	NUMBER OF FIELD DUPLICATE PAIRS[2][3]	MATRIX SPIKES[2][3]	NUMBER OF EQUIPMENT BLANKS[2][3]	TOTAL NUMBER OF SAMPLES TO LABORATORY[1]
Solid (soil/sediment)	Pesticides (TAL)	26 locations; 5 estimated samples per location (110 samples)	1/10 (11 duplicates)	1/20 (6 MS/MSD)	1/10 (none)	127
Solid (soil/sediment)	TOC	26 locations; one sample per location	1/10 (3 duplicates)	1/20 (2 MS/MSD)	1/10 (none)	31
Surface Water	Pesticides (TAL)	26 locations	1/10 (3 duplicates)	1/20 (2 MS/MSD)	1/10 (none)	31
Fish Tissue	Pesticides (TAL)	Locations TBD (64 samples)	None	1/20 (3 MS/MSD)	1/20	67
Fish Tissue	Lipids	Locations TBD (64 samples)	None	None	None	67
Fish Tissue	Necropsy and histo-pathology	Locations TBD (34 samples)	None	NA	NA	34
Groundwater	Pesticides (TAL)	8 locations	1/10 (1 duplicate)	1/20 (1 MS/MSD)	1/10 (1 blank)	11
Groundwater	VOCs (TAL)	8 locations	1/10 (1 duplicate)	1/20 (1 MS/MSD)	1/10 (1 blank)	11
Wipe Samples	Pesticides (TAL)	8 locations	None	None	1/20 (1 blank)	9

Footnotes:
[1] Number of samples is estimated. Actual number of samples will be determined in the field.
[2] Equipment blanks will be collected at the specified frequency only when non-disposable and non-dedicated sampling equipment is used.
[3] "1/10" means one QC sample collected for every 10 (or fewer) primary samples; "1/20" means one QC sample collected for every 20 (or fewer) samples.

Table 3
Summary of Sample Containers, Preservatives, and Holding Time Requirements
EE/CA Investigation – Phase I and Phase II
Area 7 of the AUS OU – Crab Orchard National Wildlife Refuge NPL

MATRIX	ANALYTICAL GROUP	CONCENTRATION LEVEL	SAMPLE VOLUME[(2)]	CONTAINERS (number, size, and type)	PRESERVATION REQUIREMENTS (chemical, temperature, light protected)	MAXIMUM HOLDING TIME (preparation/ analysis)
Water	Pesticides (TAL)	Low, Medium, and High	1-L	(2) 1-L amber bottle	4°C ± 2°C, amber jar	7 days/40 days
Soil/Sediment	Pesticides (TAL)	Low, Medium, and High	5 g	4-oz amber jar	4°C ± 2°C, amber jar	14 days/40 days
Fish Tissue	Pesticides (TAL)	Low, Medium, and High	20 g	Whole fish wrapped in extra heavy duty aluminum foil in sealable plastic bag	4°C ± 2°C	14 days to extraction 40 days to analysis
Wipes	Pesticides (TAL)	Low, Medium, and High	1 wipe	4-oz amber jar	4°C ± 2°C, amber jar	14 days/40 days
Water	VOC (TAL)	Low, Medium, and High	10 mL	(2) 40-mL vials	HCl (pH <2 SU), 4°C ± 2°C	14 days
Soil/Sediment	VOC (TAL)	Low, Medium, and High	10 g	Lock-n-Load™ glass vial and 4-oz plastic jar	10 mLs of methanol, 4°C ± 2°C Unpreserved	14 days
Soil/Sediment	PAH (TAL)	Low, Medium, and High	5 g	4-oz amber jar	4°C ± 2°C, amber jar	14 days/40 days
Soil/Sediment	TOC	Low, Medium, and High	0.05 g	4-oz amber jar	4°C ± 2°C, amber jar	28 days
Fish Tissue	Lipids	Low, Medium, and High	20 g	Whole fish wrapped in extra heavy duty aluminum foil in sealable plastic bag	4°C ± 2°C	1 year

Note:
See QAPP Worksheet #19.

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TRC - GIS

BASE MAP FROM USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE SERIES.

N

1 " = 2,000 '
1:24,000

0 2,000 4,000
FEET

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Madison, WI 53717
Phone: 608.826.3600

EE/CA INVESTIGATION PHASE I
AREA 7 PESTICIDE AREA, AUS OU
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

SITE LOCATION MAP

DRAWN BY:	PAPEZ J
APPROVED BY:	TRS
PROJECT NO:	194355
FILE NO.	194355-001-slm.mxd
DATE:	JUNE 2013

FIGURE 1

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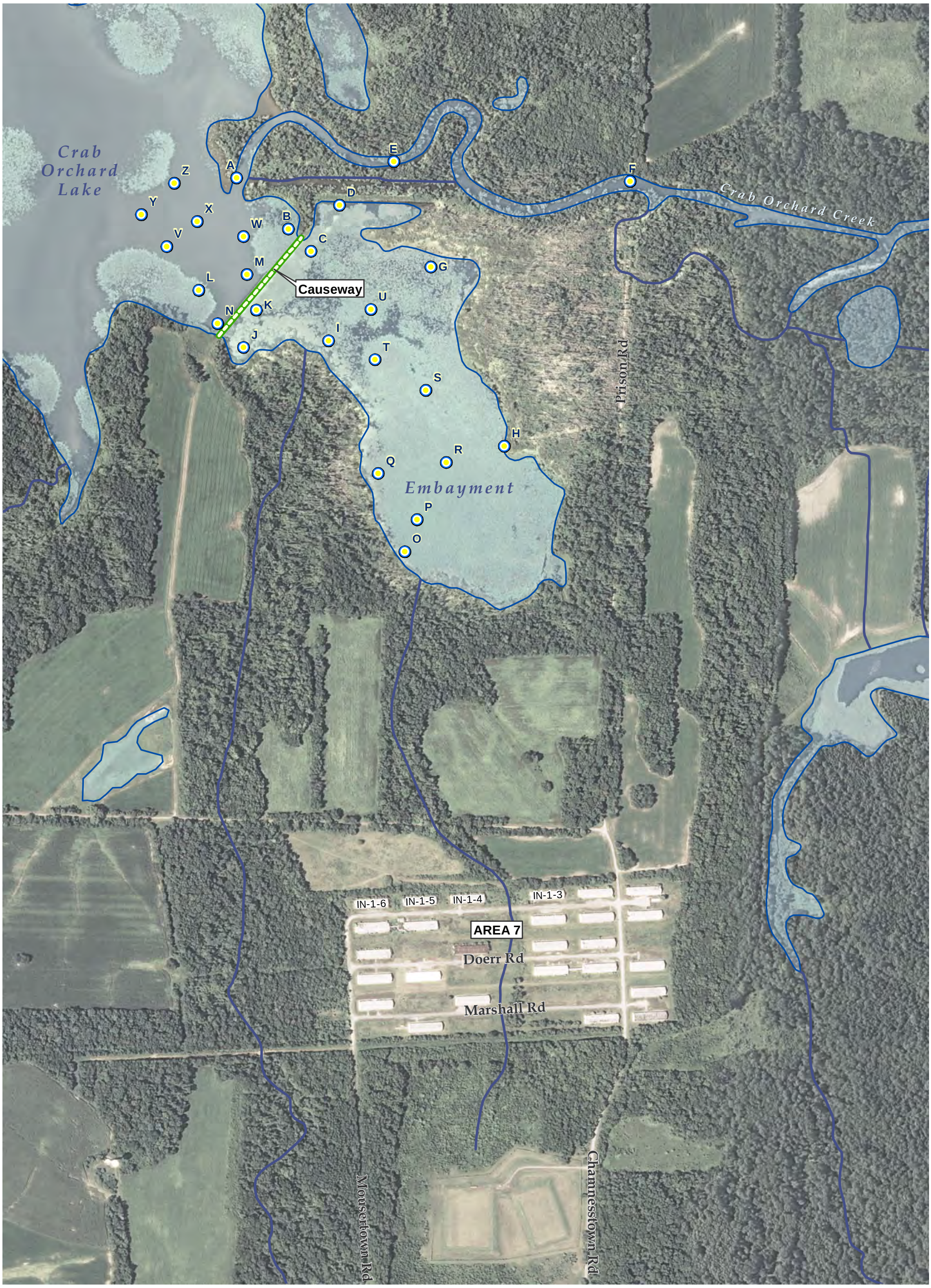

LEGEND

- PROPOSED SURFACE WATER AND SEDIMENT SAMPLE LOCATION
- DRAINAGE WAY
- WATER BODY

NOTES

1. BASE MAP IMAGERY FROM USDA - NATIONAL AGRICULTURE IMAGERY PROGRAM, AUGUST 2011.
2. HYDROLOGY FEATURES FROM USGS - NATIONAL HYDROGRAPHY DATASET.

N

0 600 Feet

1 " = 600 '

1:7,200

EE/CA INVESTIGATION PHASE I
AREA 7 PESTICIDE AREA, AUS OU
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PROPOSED SURFACE WATER AND SEDIMENT SAMPLING LOCATIONS

DRAWN BY:	PAPEZ J	SCALE: 1: 7,200	PROJ. NO. 194355-002
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APPROVED BY:	TRS	DATE PRINTED:	**FIGURE 2**
DATE:	JUNE 2013		

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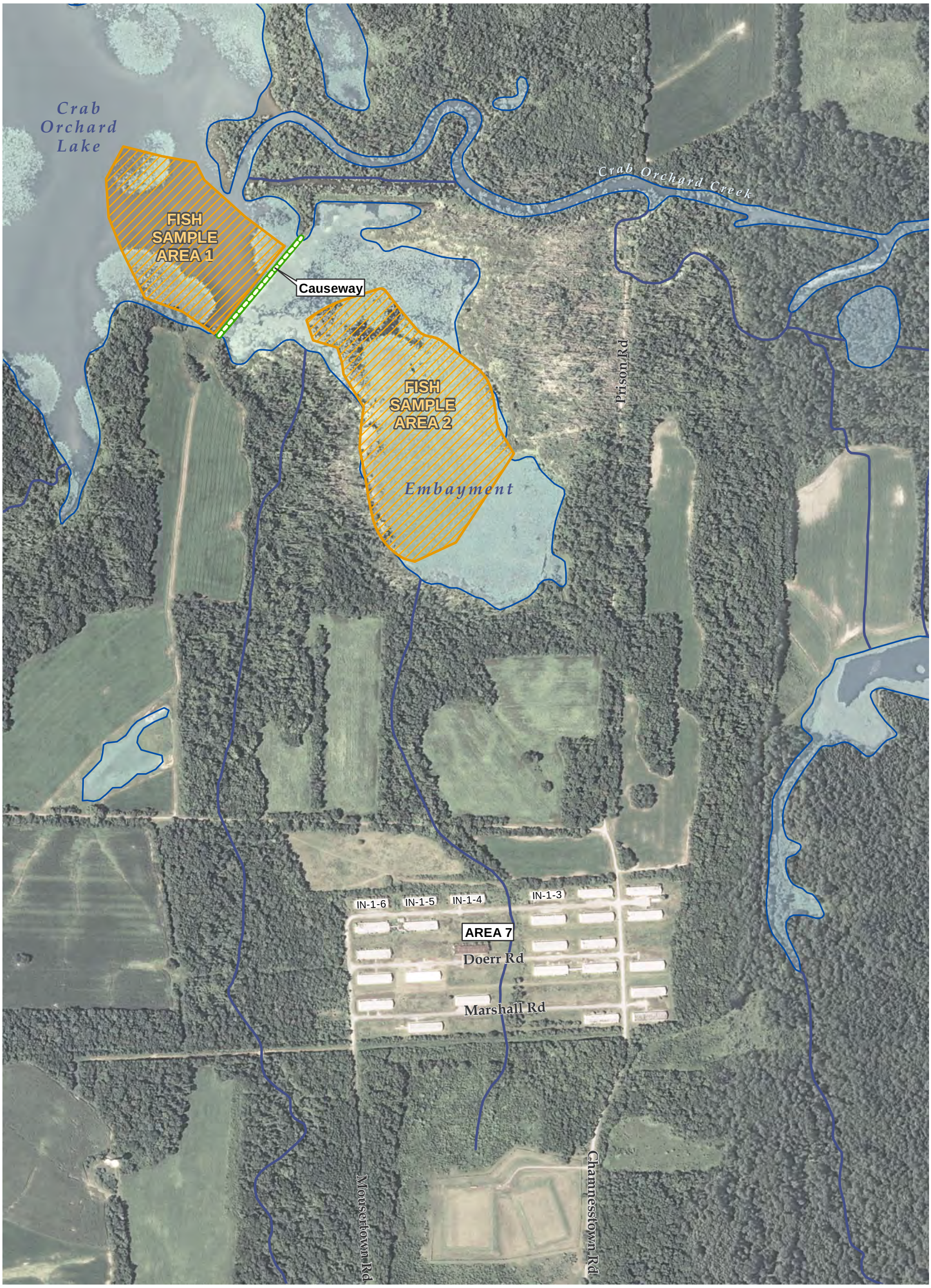
Coordinate System: NAD 1983 UTM Zone 16N (Meter)
Map Rotation: 0Degrees

TRC - GIS



LEGEND

- PROPOSED FISH SAMPLING AREA
- DRAINAGE WAY
- WATER BODY

NOTES

1. BASE MAP IMAGERY FROM USDA - NATIONAL AGRICULTURE IMAGERY PROGRAM, AUGUST 2011.
2. HYDROLOGY FEATURES FROM USGS - NATIONAL HYDROGRAPHY DATASET.

N

0 600 Feet

1 " = 600 '

1:7,200

EE/CA INVESTIGATION PHASE I
AREA 7 PESTICIDE AREA, AUS OU
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PROPOSED FISH SAMPLING AREAS

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CHECKED BY:	AAS			FILE NO.	194355-003-fsh.mxd
APPROVED BY:	TRS	DATE PRINTED:		**FIGURE 3**	
DATE:	JUNE 2013				

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Coordinate System: NAD 1983 UTM Zone 16N (Meter)
Map Rotation: 0Degrees

TRC - GIS

Coordinate System: NAD 1983 UTM Zone 16N (Meter)
Map Rotation: 0

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W-22
W-23
W-21
W15
W01
W02
W17
W08
W10
W09
W03
W11
W16

IN-1-6
IN-1-5
IN-1-4
IN-1-3
IN-2-6
IN-2-5
IN-2-3
IN-3-6
IN-3-4
IN-3-3

Mousertown Rd
Doerr Rd

420 422 424 426 428 430 432 434 436

LEGEND

- EXISTING MONITORING WELL LOCATION
- TEMPORARY WELL LOCATION (PRESUMED TO BE ABANDONED)
- PROPOSED MONTORING WELL LOCATION
- FLOW LINE

NOTES

1. BASE MAP IMAGERY FROM USGS HIGH RESOLUTION STATE ORTHOIMAGERY FOR WILLIAMSON COUNTY, IL, MARCH 2011.
2. OTHER MAP INFORMATION FROM PHOTOGRAMMETRIC SITE SURVEY CONDUCTED IN 2000.

N

0 100 200 Feet

1 " = 100 '
1:1,200

EE/CA INVESTIGATION PHASE I
AREA 7 PESTICIDE AREA, AUS OU
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PROPOSED MONITORING WELL LOCATIONS

DRAWN BY:	PAPEZ J	SCALE: 1: 1,200	PROJ. NO. 194355-002
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APPROVED BY:	TRS	DATE PRINTED:	**FIGURE 4**
DATE:	JANUARY 2014		

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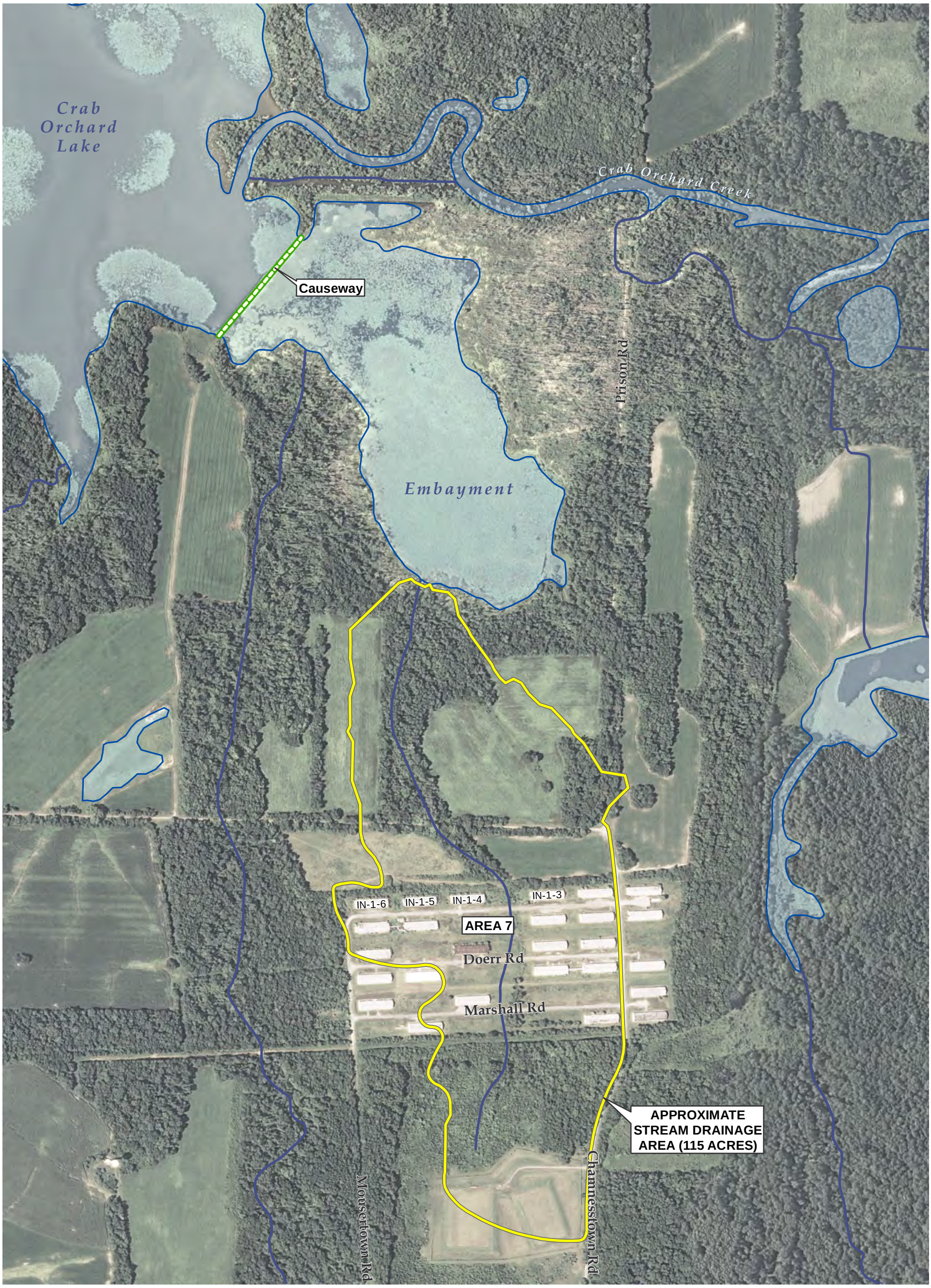

LEGEND

- DRAINAGE WAY
- WATER BODY
- WATERSHED BOUNDARY

NOTES

1. BASE MAP IMAGERY FROM USDA - NATIONAL AGRICULTURE IMAGERY PROGRAM, AUGUST 2011.
2. HYDROLOGY FEATURES FROM USGS - NATIONAL HYDROGRAPHY DATASET.

N

0 600 Feet

1 " = 600 '

1:7,200

EE/CA INVESTIGATION PHASE I
AREA 7 PESTICIDE AREA, AUS OU
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

DRAINAGE AREA AND SURVEY EXTENT

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APPROVED BY:	TRS	DATE PRINTED:		**FIGURE 5**	
DATE:	JUNE 2013				

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Coordinate System: NAD 1983 UTM Zone 16N (Meter)
Map Rotation: 0Degrees

TRC - GIS

Attachment 1
Field Standard Operating Procedures

REFERENCE NUMBER	TITLE, REVISION DATE, AND/OR NUMBER
SOP-01	SOP 1: Decontamination of Drilling Rigs and Equipment, Crab Orchard National Wildlife Refuge; April 2012
SOP-02	SOP 2: Decontamination of Field Equipment, Crab Orchard National Wildlife Refuge; April 2012
SOP-03	SOP 3: Borehole Installation and Sampling (Overburden), Crab Orchard National Wildlife Refuge; April 2012
SOP-04	SOP 4: Surface Soil Sampling, Crab Orchard National Wildlife Refuge; April 2012
SOP-05	SOP-5: Overburden Monitoring Well Construction and Development, Crab Orchard National Wildlife Refuge; April 2012
SOP-06	SOP-6: Groundwater and Fluid Level Monitoring, Crab Orchard National Wildlife Refuge; April 2012
SOP-07	SOP-7: Groundwater Sampling, Crab Orchard National Wildlife Refuge; April 2012
SOP-08	SOP-8: Single Well Response Tests, Crab Orchard National Wildlife Refuge; April 2012
SOP-09	SOP-9: Sample Management and Field QA/QC, Crab Orchard National Wildlife Refuge; April 2012
SOP-10	SOP-10: Fish Sampling, Crab Orchard National Wildlife Refuge; April 2012
SOP-11	SOP-11: Management of Investigation Derived Waste, Crab Orchard National Wildlife Refuge; April 2012
SOP-12	SOP-12: Decontaminating Re-usable Dissection and Sample Collection Tools. Taken from Hudson River Fish Health Assessment SAP, Hudson River Natural Resource Trustees; October 2001.
SOP-0025-002	ENTRIX SOP #0025 002: Standard Operating Procedure for Collecting Sediment Samples; Revision 3.5 (February 27, 2009; Addendum April 29, 2010
SOP-0025-003	ENTRIX SOP #0025 003: Standard Operating Procedure for Collecting Surface Water Samples; Revision 3.7 (March 11, 2009; Addendum April 29, 2010
ECCS-01	PCB and Pesticide Wipe Analysis, Supplemental Sample Collection Guidance
TRC-004	Calibration of Field Instruments for Water Quality Parameters

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 1
DECONTAMINATION OF DRILLING RIGS AND EQUIPMENT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

This Site-Specific SOP describes decontamination procedures for drill rigs, heavy equipment/vehicles and other tools and equipment brought to the Refuge (or Site)[1] for use in soil and groundwater investigations, and other related activities. Physical and chemical methods are used to clean and decontaminate heavy equipment, vehicles, tools and other equipment. Decontamination of this equipment is required to:

- prevent the spread of contaminants within the site
- prevent cross-contamination by workers' use of potentially contaminated equipment within the site
- reduce the potential for worker exposure to contaminants
- improve data quality and reliability.

GENERAL

Ensure all equipment brought to the Refuge is in good repair and free from oil, grease, hydraulic fluid, dirt, rust, and debris. Sandblast all downhole auguring, drilling, and sampling equipment before use if it is painted or if there is a buildup of rust, hard or caked matter, etc., that cannot be removed by detergent and high-pressure hot water or wire brushing. Perform sandblasting prior to arrival at the Refuge. Additionally, upon arrival at the Refuge, a Fish and Wildlife (FWS) representative will inspect the drilling rigs, support vehicles, and all associated sampling and drilling equipment. Any equipment or supplies found to be unsuitable must be removed from the Site.

After decontamination of downhole and other drill rig equipment (e.g., augers, split spoons, drive shoe, drilling tools, MacroCores™, etc.) and associated tools, wear clean gloves to handle the equipment to prevent re-contamination. Do not place equipment or tools in or on any area that may have been exposed to potentially contaminated media after the final rinse. If equipment and tools are to be stored on a drill rig, place them on and cover them with unused clean plastic sheeting. Do not set decontaminated equipment or tools on any surface that has not been decontaminated. If equipment is stored overnight, secure the plastic sheeting to ensure that it stays in place. Transport and store equipment, tools, and containers separate from gasoline, oil, grease, solvents, pesticides or any other possible contaminants. Decontaminate all equipment (drill rigs, vehicles, trailers, tools, equipment, containers, etc.) before removal from the Refuge.

Properly segregate, containerize, label, and store wash waters, solid matrix debris, and spent personal protective equipment (PPE) as described in SOP 11.

Document all deviations from the procedures required by this SOP in a standard bound field logbook (logbook). In addition, implement corrective action as described in Worksheets #6,

[1] As defined in the Administrative Order on Consent.

#14, #31-1, and #32-1 of the Quality Assurance Project Plan (QAPP). If corrective action is not required, describe the basis for that determination in the logbook.

PRIOR PLANNING AND PREPARATION

Preparatory tasks prior to equipment decontamination:

i) Assemble and inventory necessary cleaning equipment and supplies.

ii) Review specific equipment decontamination protocols.

iii) Ensure that arrangements have been made for acquisition, storage, and transportation, and disposal of cleaning fluids.

iv) Set up equipment decontamination area(s).

EQUIPMENT NEEDS

Equipment required (additional equipment may be needed) to complete the tasks associated with this SOP:

- potable[2] water
- electrical source
- saw horses or risers no less than 2' above the ground
- 5-gallon buckets
- plastic sheeting
- secondary containment or "kiddie" tubs
- laboratory-grade organic-free water[3]
- high-pressure hot water washer capable of generating a pressure of at least 2,500 psi with a detergent compartment (supplied by drilling contractor)
- liquid and solid matrix IDW storage tanks/facilities
- trash pumps and hoses
- brushes

[2] Obtain potable water from a clean source and contain it in a pre-cleaned poly tank.
[3] Organic-free water: Tap water treated with activated carbon and de-ionizing units. At a minimum, the finished water must meet the analytical criteria of de-ionized water and it should contain no detectable pesticides, herbicides, or extractable organic compounds, and no volatile organic compounds above minimum detectable levels for a given set of analyses. De-ionized water: Tap water passed through a standard de-ionizing resin column. At a minimum, the finished water should contain no detectable heavy metals or other inorganic compounds above analytical detection limits as defined by a standard inductively coupled Argon Plasma Spectrophotometer (ICP) (or equivalent) scan. Organic-free water may be substituted for de-ionized water.

- phosphate-free (ammonia-free) detergent
- PPE as specified in the Health and Safety Plan (HASP)

FIELD PROCEDURE

Upon every first mobilization at the Refuge and prior to any drilling activity, decontaminate the rig, support vehicles (trailers, truck beds, tanks, etc.), clearing and grubbing equipment (backhoes and related equipment), equipment used to dig post holes, and all associated drilling and sampling tools and equipment (including pumps and hoses). Remove oil, grease, mud, rust, and other foreign matter in accordance with the steps outlined in this SOP.

A. Handling and Storage of Cleaning Solutions

Improper handling and storage of cleaning solutions can cause them to become contaminated. Ensure the storage and application containers are constructed of the proper materials to protect the integrity of cleaning solutions.

Acceptable containers for cleaning solutions are as follows:

- Store and pour phosphate-free detergent from the original manufacturers' container.
- Store potable water in clean poly-tanks or decontaminated buckets, or apply directly from a clean hose.
- Store and pour laboratory-grade organic-free water from the original manufacturer's container. However, application may be done using clean polytetrafluoroethylene (PTFE) squeeze bottles. Obtain unused PTFE bottles at the beginning of the project. The outside of the containers must be visibly clean of dirt.[4]

Note: Do not use hand pump sprayers (including stainless steel sprayers) for the storage or application of the above solutions because internal oil coated gaskets and rubber seals may contaminate them.

B. Auger/Sonic Rigs and Associated Equipment

1. Drilling Rigs

To prevent cross-contamination, following completion of drilling activities at each location within the site, inspect the portion of the rig that is over the intrusive location (the kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pull-downs, spindles, cathead, etc.) to determine if this equipment shows signs of contact with potentially impacted soils.

[4] Clean the outside of PTFE bottles using a phosphate-free detergent water wash, followed by two potable water rinses. Each time the PTFE bottle is filled, rinse the inside of the bottle with the type of water it is being used for.

Decontaminate any portion of the rig exposed to potentially contaminated materials in accordance with this SOP. Following completion of drilling activities at the site, decontaminate the entire drill rig, including those portions that were over the intrusive location. Decontaminate the rig at the central decontamination pad.

The following describes to decontamination procedure:

i) Brush and wash with a high-pressure, hot-water power wash system (as described in *Equipment Needed*) using a phosphate-free detergent and potable water solution to remove foreign matter.

ii) Rinse with a high-pressure potable water wash to remove soap and contaminants.

iii) Move decontaminated equipment away (preferably upwind) from the central decontamination pad to prevent re-contamination.

If a pump is used to circulate drilling fluids or bentonite grout, flush the pump and tank on the rig with tap water until clear and then drain. If used, flush the pump on the grout mixer with tap water until clear and then drain.

Do not track contamination from one area to another with other potentially contaminated equipment like the tracks of rigs, bobcats, and backhoes for example. Decontaminate this equipment between locations in the same manner noted above.

A FWS representative will verify that the recirculation tanks (inside and out) as well as water tanks (inside and out) are included on the list of equipment to be decontaminated.

2. Downhole Drilling and Associated Equipment

After use, place downhole equipment, including augers, on clean plastic sheeting before transporting back to the central decontamination pad.

Before initiating drilling or sampling at each borehole, decontaminate downhole drilling equipment (augers, cutting bits, samplers, tools, and other associated equipment) that have come in contact with soil or drilling fluids to prevent potential cross-contamination from previous drilling activities. Decontaminate downhole drilling and associated equipment using the same steps noted in Section B.1, *Drilling Rigs*. However, if used, the pump on the grout mixer will be flushed with tap water until clear and then drained. Wash the grout mixer with soap and potable water. The high-pressure, hot-water power wash may also be used.

Note: Decontaminate hoses, recirculation tanks, and tremie pipes prior to use.

When using the high-pressure, hot water system, clean downhole drilling and associated equipment on racks or saw horses at least 2 feet above the floor of the decontamination pad. Do not use pallets. Decontaminate the inside of augers, drill rods, etc., that are hollow or have

holes to transmit water or drilling fluids. Brush vigorously to remove material that the high-pressure hot wash cannot remove.

A FWS representative will inspect all rigs, truck beds, trailers and other vehicles used to transport decontaminated materials to determine if these vehicles show signs of contact with potentially contaminated soil or other media. If so, these vehicles will be decontaminated in accordance with this SOP.

3. Split Spoon Sampler, Drive Shoe, and Miscellaneous Tools

Decontaminate the split spoon sampler and the drive shoe between each sample interval and each borehole. Decontaminate the drilling tools and associated equipment between boreholes. This includes, but is not limited to, auger forks and foot clamps, auger wrenches, AW rods, fishing tools for recovering equipment lost in the borehole, auger pins, safety hooks, hoisting tools, tools for coupling and uncoupling drill strings or augers, hammers, pliers, vice grips, screwdrivers, and tape measures including weighted flexible tape measures.

Decontaminate the split spoon sampler, drive shoe, and other miscellaneous equipment and tools in a series of clean, 5-gallon plastic buckets[5] as described below:

i) Brush and wash the equipment with a phosphate-free detergent and potable water solution in the first bucket.

ii) Rinse with potable water (first rinse) in the second bucket.

iii) Rinse with potable water (second rinse) in the third bucket.

iv) Rinse with laboratory-grade organic free water (final rinse) in the fourth bucket.

C. Direct-Push Technology (DPT) Drilling Rigs and Equipment

1. DPT Rig

To prevent cross-contamination, decontaminate DPT rigs between each borehole. Decontaminate the portion of the rig that is over the intrusive location, or any other portion that has encountered potentially contaminated soil, using the steps outlined in Section B.1, *Drill Rig*.

2. Drive Shoe, Sampler and Associated Equipment

Before initiating drilling or sampling at each location and between sample intervals, decontaminate downhole drilling equipment (drill rods, samplers, tools, and associated equipment) that have come into contact with soil or appear to have come into contact with soil,

[5] Decontaminate the buckets used for decontamination prior to use by washing with a phosphate-free detergent and potable water solution followed by two potable water rinses. Contain the buckets in a small enclosure, such as a plastic "kiddie" pool, to act as secondary containment for the wash solution and rinse waters. Prevent wash and rinse waters from spilling to the surrounding ground surface. Replace rinse and detergent water with new solutions between borings.

to prevent potential cross-contamination. Decontaminate drilling tools and associated equipment between boreholes. This includes, but is not limited to, auger forks and foot clamps, auger wrenches, AW rods, fishing tools for recovering equipment lost in the bore hole, auger pins, safety hooks, hoisting tools, tools for coupling and uncoupling drill strings or augers, hammers, pliers, vice grips, screwdrivers, and tape measures including weighted flexible tape measures.

Note: Decontaminate hoses, recirculation tanks, and tremie pipes prior to use.

Decontaminate the DPT rig, drive shoe, sampler (such as a Geoprobe®), and associated tools and equipment in a series of clean, 5-gallon plastic buckets[6] as described in Section B.3, *Split Spoon Sampler, Drive Shoe, and Miscellaneous Tools*.

D. Central Decontamination Facilities

Construct a central decontamination pad to accommodate decontamination of all drilling rigs, trailers, trucks and equipment upon arrival to the Refuge, prior to performing drilling activities, between each boring location, and upon completion of work before leaving the Refuge. Ensure that the central decontamination pad has the appropriate equipment to thoroughly clean the drilling rigs, associated equipment, and vehicles as described herein and to facilitate capture of cleaning fluids and other media for proper management. Construct the decontamination pad to have sufficient capacity and pumping capability to prevent any overflow of leaking fluids or other media during decontamination activities, and when no decontamination activities are occurring. Additionally, remove water and other media from the decontamination pad after every use.

Figure 1 depicts the general detail of the central decontamination pad. Although not shown on the figure, use cattle fencing covered with polyethylene sheeting to contain overspray. Do not place equipment on pallets or on the floor of the central decontamination pad during or after cleaning. Use sawhorses or risers no less than 2 feet above the bottom of the decontamination pad to hold equipment while cleaning. The central decontamination pad must be constructed so that water from decontamination does not drain to the outside of the pad. The central decontamination pad will be placed within the exclusion zone at a location approved by the FWS. The location will be shown in the Health and Safety Plan.

[6] Ibid

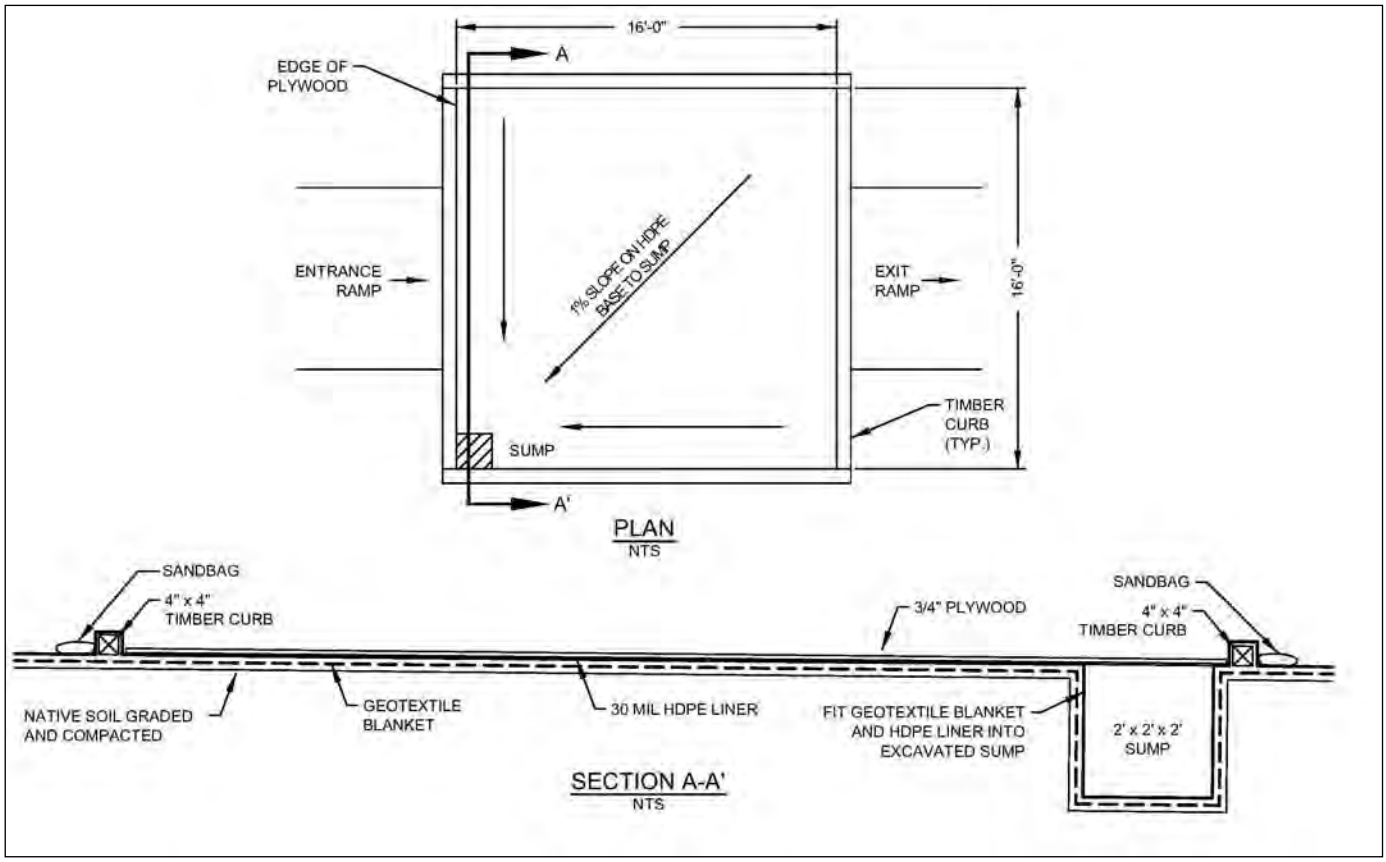

Figure 1: Central Decontamination Pad

E. Temporary Decontamination Facilities

In order to more efficiently complete the fieldwork, in addition to the central decontamination pad, a number of temporary decontamination facilities may be constructed and operated to clean downhole drilling equipment. Use of these temporary facilities will eliminate the need to travel potentially large distances from remote areas of the site to the central decontamination pad. These temporary facilities should have the appropriate equipment to clean the drilling equipment, drilling tools, and sampling equipment thoroughly.

To facilitate capture of cleaning fluids and sediments for proper management:

i) Contain fluids at the temporary decontamination facilities with a large metal trough, steel drum, or "kiddy" pool.

ii) Transfer decontamination fluids and media to 55-gallon drums and stage at the temporary decontamination facilities.

iii) Move drummed decontamination fluids and media to the central staging area upon completion of the investigative work in the area but at a frequency of no less than once per week.

iv) Label and handle drums in accordance with the procedures outlined in SOP 11.

v) Thoroughly decontaminate drums and containers before leaving the Refuge.

A FWS representative will inspect the central and temporary decontamination facilities daily, prior to use, and upon removal to confirm proper restoration of the decontamination areas. The representative will document inspections in a logbook and will include comments on integrity of the decontamination pad, its state of repair, the need for repair, any leaks or overspray, and any actions taken to address any immediate concerns.

RECORDED INFORMATION

Document decontamination activities completed for drill rig, heavy equipment, vehicles, and associated tools and equipment in a bound logbook. Include the following in the field logbook:

- site location, date, time, weather
- equipment use location
- decontamination location
- name of personnel performing decontamination
- PPE worn during decontamination activities
- decontamination procedures*
- sources of materials (solutions) used for decontamination
- volume of decontamination fluids generated
- location where decontamination fluids have been stored
- name of the individual(s) approving adequacy of decontamination
- QA/QC sampling performed (if required).

* It is not sufficient to write in the logbook "decontamination was done in accordance with the SOP". Rather, the field logbook should detail the steps and materials used for decontamination, the equipment that was decontaminated, and all the requirements as noted above.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 2
DECONTAMINATION OF FIELD EQUIPMENT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

This Site-Specific SOP describes decontamination procedures for field equipment used in the sampling of soil, sediment, surface water and groundwater that undergo either physical or chemical analyses. This SOP excludes procedures for decontamination of downhole drilling and DPT soil sampling tools (i.e., split spoon samplers, drilling rods, core barrels, Macrocore™ sampler, etc.) used to collect soil samples for chemical analysis, which are specifically addressed in Site-Specific SOP 1.

The purpose for decontamination of soil and groundwater field equipment is to:

- prevent cross-contamination of individual sampling sites and specific sampling locations
- ensure that representative samples are collected for analysis
- ensure proper operation of equipment and instrumentation
- reduce exposure hazards to workers involved in handling potentially contaminated materials
- improve data quality and reliability.

GENERAL

Properly segregate, containerize, label, and store wash waters, solid matrix debris, and spent PPE as described in SOP 11.

Document all deviations from the procedures required by this SOP in a standard bound field logbook (logbook). In addition, implement corrective action as described in Worksheets #6, #14, #31-1, and #32-1 of the Quality Assurance Project Plan (QAPP). If corrective action is not required, describe the basis for that determination in the logbook.

PRIOR PLANNING AND PREPARATION

Preparatory tasks for the decontamination of soil and groundwater field equipment:

i) Assemble and inventory necessary decontamination equipment and supplies.

ii) Review specific equipment decontamination protocols.

iii) Check on acquisition, storage, and transportation of cleaning fluids.

iv) Evaluate disposition of cleaning fluids upon completion of the work.

v) Set up equipment decontamination area(s).

vi) Decontaminate all equipment before removing it from the Refuge.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 2
DECONTAMINATION OF FIELD EQUIPMENT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

EQUIPMENT NEEDS

Equipment required (additional equipment may be needed) to complete the tasks associated with this SOP:

- potable[1] water
- laboratory-grade distilled water
- 5-gallon buckets for washing and rinsing tools and equipment
- secondary containment or "kiddie" tubs
- liquid and solid matrix IDW storage containers
- plastic sheeting
- PTFE check valves
- aluminum foil
- brushes
- phosphate-free, (ammonia-free) detergent
- PPE as specified in the HASP.

FIELD PROCEDURE

The decontamination procedures for field equipment can be subdivided into two categories of cleaning:

i) Those pieces of equipment that will come in direct contact with samples that are to be submitted for chemical analysis (i.e., pumps, stainless steel trowels, hand augers, etc.).

ii) Those pieces of equipment that are used to obtain field measurements (i.e., pH meters, temperature probes, water level meters, etc.).

The first category of equipment requires extensive, documented and defensible procedures. The second category requires less intensive cleaning procedures. Both categories of decontamination are described below.

[1] Obtain potable water from a clean source and contain it in a pre-cleaned poly tank.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 2
DECONTAMINATION OF FIELD EQUIPMENT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

A. Handling and Storage of Cleaning Solutions

Improper handling and storage of cleaning solutions can cause them to become contaminated. Ensure the storage and application containers are constructed of the proper materials to protect the integrity of cleaning solutions.

Acceptable containers to store and pour the following cleaning solutions are as follows:

- Store and pour phosphate-free detergent from the original manufacturers' container.
- Store potable water in clean poly-tanks or decontaminated buckets, or apply directly from a clean hose.
- Store and pour laboratory-grade organic-free water from the original manufacturers' container. However, application may be done using clean PTFE squeeze bottles. Obtain unused PTFE bottles at the beginning of the project. The outside of the containers must be visibly clean of dirt.[2]

Note: Do not use hand pump sprayers (including stainless steel sprayers) for the storage or application of the above solutions because internal oil coated gaskets and rubber seals may contaminate them.

B. Equipment Which Contacts Samples to be Chemically Analyzed

1. Soil and Sediment Sampling Equipment

Decontaminate non-disposable soil and sediment sampling equipment (trowels, bowls, spoons, hand shovels, hand augers, scoops, knives, tape measures, or any other tools or equipment that comes into contact with potentially contaminated soil or sediment) prior to field use and after each sample interval to prevent cross-contamination between sample locations and sample intervals. Collect duplicate samples concurrently with original samples to eliminate the need to decontaminate the sampling equipment before collecting duplicate samples. When transporting used or potentially contaminated equipment to the decontamination area, take care to prevent the spread of contaminants.

[2] Clean the outside of PTFE bottles using a phosphate-free detergent water wash, followed by two potable water rinses. Rinse the inside of the bottle with the type of water it is being used for after every volume.

Decontaminate equipment used for collecting samples for laboratory analyses in a series of clean, 5-gallon plastic buckets[3] as described below:

i) Disassemble equipment as appropriate.

ii) Brush and wash the equipment with a phosphate-free detergent and potable water solution to remove any particles or surface film in the first bucket.

iii) Rinse with potable water (first rinse) in the second bucket.

iv) Rinse with DI water (second rinse) in the third bucket.

v) Rinse with laboratory-grade organic free water (final rinse) in the fourth bucket.

vi) Visually inspect equipment to verify that it is free of soil particles and other solid material that could contribute to sample cross-contamination.

vii) Allow equipment to air-dry on a clean plastic sheet for as long as possible.

viii) When the equipment is dry, wrap it in clean unused aluminum foil or clean unused plastic sheeting before transporting to a sampling location.

After decontamination, wear clean gloves to handle equipment to prevent recontamination. Never handle equipment without gloves to prevent recontamination.

2. Groundwater Sampling Equipment

Groundwater samples are collected using a stainless steel bladder pump or stainless steel electric submersible pump. Decontaminate the bladder and electronic submersible pumps using a large tub and PVC tubes as described below:

i) Disassemble pumps as necessary and appropriate.

ii) Using a large tub, prepare a phosphate-free detergent and potable water rinse for brushing all visible foreign matter from the pump.

iii) Place the pump in a clean 2- to 4-inch diameter polyvinyl chloride (PVC) tube or a plastic tub containing a phosphate-free detergent and potable water solution.

iv) Activate pump and allow water/detergent solution to circulate through pump and tubing (if applicable) for three minutes, then remove the pump.

v) Place the pump in a clean 2- to 4-inch PVC tube and add 2 gallons of laboratory-grade distilled water.

[3] Decontaminate the buckets used for decontamination prior to use by washing with a phosphate-free detergent and potable water solution followed by two potable water rinses. Contain the buckets in a small enclosure, such as a plastic "kiddie" pool, to act as secondary containment for the wash solution and rinse waters. Prevent wash and rinse waters from spilling to the surrounding ground surface. Replace rinse and detergent water with new solutions between borings.

vi) Activate pump and allow laboratory-grade distilled water to circulate for three minutes then remove the pump from the PVC tube.

vii) Visually inspect equipment to verify that it is free of soil particles and other solid material that could contribute to sample cross-contamination. If not, repeat the above steps.

viii) Transport pump to the next sampling location on unused plastic sheeting.

Additionally, decontaminate the PTFE check valve in the same manner noted in this SOP under *Section B.1.* In addition, some electric submersible pumps have a cooling chamber; if so, replace the water in the cooling chamber with organic-free water between each well.

Note: If a pump such as the QED Sample Pro Portable Bladder Pump is used to sample a monitoring well, eliminate *items iii* through *vi* because this type of pump is designed to be completely disassembled for decontamination. Install a new bladder between sample locations, and rinse all parts of the bladder pump with laboratory-grade organic free water prior to reassembly.

C. Equipment Which Does Not Contact Samples Requiring Chemical Analysis

This category of cleaning includes sampling equipment used for collecting samples for physical analysis (i.e., inspection, grain-size distribution, etc.) and also includes those pieces of equipment that perform in field testing where no subsequent analyses of that portion of the sample is to be analyzed any further (i.e., pH meter, temperature probes, etc.).

For all field testing equipment, follow the manufacturer's specifications for cleaning. Other cleaning methods may affect the instruments operating functions.

Clean equipment placed into monitoring wells such as water level meters and pressure transducers with a phosphate-free detergent and potable water solution then rinse with laboratory-grade organic free water. Prior to use at the site, decontaminate the entire portion of the water level meter tip and the entire length of the tape. After use at each location, decontaminate the entire portion of the water level meter tap and tip and the entire length of the tape that entered the well, not just the portions that came into contact with the groundwater. The same is true for the pressure transducers. Decontaminate the entire portion of the pressure transducer and wires that entered the well, not just portions that came into contact with the groundwater. Decontaminate these types of equipment over a 5-gallon bucket to contain wash waters. Transport water level meters and pressure transducers in clean containers after decontamination.

For all other sampling equipment that in this category, following use at a well or soil sample collection site and prior to use at another site location, the interior and exterior surfaces of the sampling equipment require a less stringent decontamination process to prevent the spread of

contaminants from borehole to borehole. Clean or wipe the equipment with a phosphate-free detergent and potable water solution then rinse with potable water.

Handle all used cleaning fluids and solids in accordance with the procedures outlined in SOP 11.

RECORDED INFORMATION

Document decontamination activities in a bound field logbook. Include the following information:

i) site location, date, time, weather

ii) equipment use location

iii) location where decontamination was performed

iv) personnel performing decontamination and the PPE worn/used during decontamination activities

v) decontamination procedures*

vi) sources of materials (solutions) used for decontamination

vii) volume of decontamination fluids generated

viii) location where decontamination fluids have been stored

ix) individuals approving adequacy of decontamination

x) QA/QC sampling performed (if required).

* It is not sufficient to write in the logbook "decontamination was done in accordance with the SOP." Rather, the field logbook should detail the steps and materials used for decontamination, and the equipment that was decontaminated, and all the requirements as noted above.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 3
BOREHOLE INSTALLATION AND SAMPLING (OVERBURDEN)
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

The following SOP presents the methods for the installation of boreholes (overburden). Boreholes are typically installed to investigate geologic conditions for hydrogeologic and geotechnical evaluation, for the installation of monitoring wells and piezometers, for the collection of subsurface samples for chemical analysis, and for soil record retention purposes. The basic soil description techniques as well as the collection procedures for subsurface samples are discussed.

GENERAL

Document all deviations from the procedures required by this SOP in a standard field logbook (logbook). In addition, implement corrective action as described in Worksheets #6, #14, #31-1, and #32-1 of the Quality Assurance Project Plan (QAPP). If corrective action is not required, describe the basis for that determination in the logbook.

PRIOR PLANNING AND PREPARATION

Preparatory tasks prior to borehole installation and subsurface soil sampling:

i) Review the Work Plan, Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements. The site geologist needs to be familiar with the site geology and hydrogeology as described in the *Work Plan*.

ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed.

iii) Obtain a site plan and review any existing stratigraphic information. Determine the exact number and location of boreholes to be installed and the depths of samples for chemical analysis. Assemble sample containers if needed.

iv) Review with the FWS representative whether utility clearance activities have been completed in the areas where subsurface investigations are to be conducted.

v) Evaluate access conditions with the FWS representative to determine whether any vegetation clearing is necessary to access investigative locations, and coordinate required approvals of clearing activities with the FWS.

vi) Establish a potable[1] water source for drilling and decontamination activities.

vii) Review procedures for handling and disposal of drill cuttings, wash waters, and spent decontamination fluids in SOP 11.

[1] Obtain potable water from a clean source and contain in a pre-cleaned poly tank.

EQUIPMENT NEEDS

Equipment required (additional equipment may be needed) to complete the tasks associated with this SOP:

- equipment decontamination supplies
- field logbook, field forms (hard copy or electronic)
- task specific documents and maps
- stainless steel bowls (round) and trowels
- air monitoring equipment
- PPE as specified in the HASP
- sample containers (sample container/preservative requirements are outlined in Table 3 of the FSP and Worksheet #19 of the QAPP)
- cooler and ice
- stainless steel hand auger
- camera
- re-sealable baggies

FIELD PROCEDURE

A. Location and Marking of Drill Sites/Final Visual Check

The U.S. FWS and the Respondent will attempt to pre-stake locations using maps, aerial photographs, and GPS units. However, in the event a location cannot be identified, it may need to be surveyed based on coordinates provided by U.S. FWS and the Respondent prior to sampling.

Once the final location for the proposed boring has been selected and utility clearances are complete, visually check the immediate area again before drilling. Confirm the locations of any adjacent utilities (subsurface or overhead), and verify there is adequate clearance. If gravity sewers or conduits exist in the area, open any access manholes or chambers and confirm the conduit/sewer alignments, if possible.

If it is necessary to relocate any proposed borehole due to terrain, utilities, access, etc., notify the FWS representative. This person will in turn notify both the FWS and the Respondent. FWS will determine appropriate action. Provide a 48-hour notice to the FWS if borehole relocation is necessary.

Prior to surface soil sampling, photo document the sample location and surrounding area using a digital camera of 5 megapixels or better. Include two or more reference points to help relocate the sample location in the future. Record the date and time of photographs, shot orientation, description of the shot, and the camera operator in the field logbook.

B. Equipment Decontamination for Environmental Sites

Prior to use and between each borehole location, follow the equipment decontamination procedures outlined in SOP 1 and SOP 2.

C. Direct-Push Technology (DPT)

Collect soil samples primarily using DPT, such as a Geoprobe® rig. To the extent possible, small and highly mobile DPT drill rigs (ATV rigs) are preferred to expedite sample collection activities, maximize ability to access remote locations, and minimize the volume of IDW generated during the investigation. If subsurface obstructions prevent the use of a DPT drill rig, use a drilling rig equipped with hollow stem augers (HSA).

Equip the DPT sampler with a 4-foot long MacroCore™ or a Dual Tube Sampling System (4- or 5-foot length) to obtain a sufficient volume of soil for sample collection purposes. Fit the soil sampling tool with a clean PVC liner prior to advancement to the target depth. Discard and manage the PVC liners as IDW following use.

Collect and submit DPT soil samples for laboratory analysis using the following procedure:

i) Don a new pair of disposable nitrile gloves (or equivalent) for handling each sample. Change the gloves any time during sample collection when their cleanliness is compromised.

ii) Prior to use at each sampling location, decontaminate the equipment including rig and downhole sampling equipment in accordance with SOP 1.

iii) Advance the DPT sampler equipped with a PVC liner to the top of the target interval. Release the piston head on the MacroCore™ sampler. Drive the sampler through the target depth interval to obtain the soil sample.

NOTE: The Dual Tube Sampling System achieves the collection of a discrete interval sample through advancing an outer casing rather than the use of a locking piston as described above for the MacroCore™ sampler. All other sampling methodology is the same for these two sampling systems.

iv) Retrieve the soil sample(s) by pulling the rod string and sampler from the probe hole. Remove the soil-filled liner from the sample tube while maintaining the proper orientation of the sample. Distinguish the orientation by using different designated colors (i.e. red caps on the top of the liner and black caps on the bottom). Do not use permanent markers to designate top versus bottom when collecting samples for VOCs. Do not retrieve the soil sample until the sampler is ready to process it. Cut the liner lengthwise to expose the soil and segregate any residual slough material within the liner from the remaining sample. Do not use

soil from the 0 to 0.5 foot interval for VOC sampling. For the 0.5- to 2-foot length sample interval, the sample interval consists of one aliquot (see SOP 4 for more detail on 0.5- to 2-foot [6- to 24- inch] sampling interval). For each 2- to 5-foot and 5- to 10-foot length sample intervals, measure the sample interval into two equivalent lengths (providing two equal length sample aliquots from each sample interval). The sample interval depths may be modified based on the length of DPT sampler used. Regardless of the length of sampler used, the minimum boring depth as defined in the Work Plan and FSP will be obtained.

v) Collect the soil sample(s) selected for volatile organic compound (VOC) analysis from the selected sample interval in accordance with USEPA SW-846 Method 5035 using Encore™ samplers (or other equivalent volumetric sampling device). Core three Encore (or equivalent) samplers into the center of each equivalent length of sample aliquot (at the sample intervals specified in the Work Plan) in close proximity to each other in order to collect approximately 15-grams total of soil. Prior to collecting the Encore samples, use a pre-cleaned utensil to abrade the soil that had contacted the liner at the Encore sample locations. Immediately cap, label, secure in a plastic bag, and place the recovered soil samples into a cooler containing ice pending the selection of the sample aliquot from sample interval, as discussed in *item vii* below, and shipment to the project laboratory for analysis.

NOTE: some piston type volumetric sampling devices that are used in place of Encore™ samplers to meet the requirements of Method 5035 mav require a different sample volume, and field preservation with methanol, laboratory grade deionized water, and/or sodium bisulfate. Any field preservation is performed immediately following sample collection. The "ESS Lock n Load" system as specified in the ECCS Laboratory method SOP is a piston type volumetric sampler that measures a 10-gram undisturbed sample that is immediately preserved in methanol in the field (in a glass VOA vial).

vi) Following completion of *item v* above, place and seal a representative portion of each sample aliquot in a re-sealable plastic bag for headspace monitoring. Agitate the bag, if necessary, to break up clumps of soil. After approximately 5 minutes, obtain a headspace reading by inserting the tip of the photoionization detector (PID) into the bag and recording the highest headspace reading. Record the PID reading in the Field Logbook and/or on the Log of Soil Boring form.

vii) Select VOC samples for laboratory analysis based on the results of the headspace screening. Submit the sample aliquot exhibiting the highest headspace reading to the project laboratory for VOC analysis. In the event there are no elevated

headspace readings, submit the sample from the lowermost aliquot in each of the equivalent lengths to the project laboratory for VOC analysis. Properly dispose the unused samples. Record which aliquot (upper or lower of the interval) was selected and submit for VOC analysis.

viii) Once a sample is selected for VOC analysis, collect a sample from the same aliquot from the corresponding depth interval; place it in a 2- or 4-ounce sample container; and send it to the laboratory for determination of percent moisture.

ix) Following collection of the VOC sample or when no VOC samples are required, slit the sample interval lengthwise to expose the full length of the soil sample.

x) For non-VOC analysis sample(s), transfer a representative aliquot of each length of soil sample from the target depth interval into a clean stainless steel bowl or tray and **thoroughly** homogenized using a stainless steel mixing utensil. Use a container large enough to hold the sample volume and to accommodate the procedure without spilling. In most cases, use the following cone and quartering method:

1. Mix sample to disaggregate soil to less than 1/4-in. diameter.
2. Gather soil into a pile in the middle of the container and divide into quarters.
3. Mix each quarter; then, mix soils from opposite corners together.
4. Combine the whole, and divide into quarters again.
5. Mix each quarter; then, mix soils from adjacent corners together.
6. Combine the whole, and repeat steps 2-6 until a consistent physical appearance is achieved.
7. Divide the soil into final quarters, and equally subsample as described in *item xi.*

If the soil is not amenable to cone and quartering techniques due to its high moisture content or high cohesiveness, kneading techniques may be used. Place the sample into a clean noncontaminating bag then knead the soil thoroughly to mix[2].

xi) Split the sample among the laboratory-supplied containers using the alternative shoveling method. Place a spoonful of soil in each container in sequence and repeat until the containers are full or the sample volume has been exhausted.

[2] Homogenization procedures derived from the U.S. Army Corps of Engineers *Engineering and Design – Requirements for the Preparation of Sampling and Analysis Plans*, E200-1-3, 1 Feb 2001.

Label and place the containers in a cooler with ice. Ensure that sample containers will not become submerged in water from the ice melting.

Note: If visual signs of contamination or elevated PID headspace monitoring are encountered during borehole advancement, collect a grab sample from this interval.

Subsurface soil samples will be logged by the site geologist in accordance with the Unified Soil Classification System (USCS) and the information written on the Log of Soil Boring forms. A qualified geologist is defined as an earth science or engineering professional with a college degree in geology, civil engineering, or related field, or a technician with demonstrable training and expertise in relevant soil and rock identification and classification; experienced in CERCLA and/or other projects involving hazardous waste and materials, soil and rock logging, and monitoring well installation.[3] The site geologist shall be responsible for logging; acquisitioning (and possibly shipment) of samples; monitoring of drilling operations; recording of water losses/gains and groundwater data; preparing the boring logs and well diagrams; and recording the well installation and decommissioning procedures conducted with that rig. Each site geologist shall be responsible for only one operating rig. The geologist shall have onsite sufficient tools, forms, and professional equipment in operable condition to efficiently perform the duties as outlined in this and other relevant SOPs and in other relevant project documents. Items in the possession of each site geologist will include, as a minimum, a copy of the applicable SOPs, a copy of the approved drilling and well installation plan, log forms, the approved HASP, a 10-power(minimum) hand lens, and a measuring tape (weighted with stainless steel or chemically stable, nonmetallic material) long enough to measure the deepest boring/well within the project, heavy enough to reach that depth, and small enough to readily fit within the appropriate annulus or opening. Each site geologist will also have onsite a water-level measuring device (preferably electrical), pH and electric conductivity meters, a turbidimeter, a thermometer, an instrument for measuring dissolved oxygen, and materials necessary to prepare the samples for storage or shipment. If needed, the geologist will have the necessary instruments for gas monitoring and be proficient in their use and calibration. Headspace readings obtained during borehole advancement will be recorded on the Log of Soil Boring forms.

Boreholes not used for monitoring wells will be closed by filling the borehole from the base to the ground surface with either the high solids bentonite grout or the cement bentonite grout specified in SOP 5 using a high pressure grout pump through retraction grouting or re entry grouting using a tremie tube. If borehole is located in an area contaminated with volatile organics, the cement bentonite grout should be used. Grouting should be performed prior to moving to the next borehole location. Prior to leaving the abandoned borehole, ensure that the stake marking the sample location has a clearly legible identifier and is securely in the ground so that it can be accurately surveyed. Following a period of at least 24-hours, the abandoned soil boring will be checked for settlement and if needed filled with granular bentonite hydrated

[3] Resumes or details regarding the relevant experience of proposed site geologists will be forwarded to FWS for review prior to commencement of this work. FWS will notify the Respondent of the results of the review.

with potable water. The top 6 inches of borehole will be capped with asphalt or concrete patching material or native soil as appropriate to match the existing surface. It should be recorded in the logbook how much settlement occurred.

For boreholes advanced to a maximum of 2 feet, the borehole will be abandoned by filling it from the base to the ground surface with granular bentonite in 1 foot lifts, hydrating each foot with 3.5 cups of laboratory grade deionized water.

D. Rotary Drilling Rigs

Rotary drilling rigs equipped with HSA will be required to install groundwater monitoring wells and collect soil samples. Soil samples will be collected using a rotary drilling rig equipped using a 2-foot long split-spoon sampler constructed of solid stainless steel or with a stainless steel-lined barrel.

If during the field investigation potable water is added to a borehole to facilitate the installation of a monitoring well, a sample of the potable water source will be collected and analyzed for the same parameters for which the monitoring well is to be sampled.

Rotary drill rigs will be used to advance boreholes for installing monitoring wells. Work will be done in accordance with ASTM D5784 – 95(2006), *Standard Guide for Use of Hollow-Stem Augers for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices* where applicable (or, if this standard has been updated, with the most recent version of this standard). In the event of a conflict between this SOP and the ASTM guidance, contact the U.S. Fish and Wildlife Service for direction. During the advancement of these boreholes soil samples will be collected for visual observation and logging purposes. The stratigraphic information collected will be used to determine the depth at which to set the screen interval and to better define the stratigraphic conditions. Soil samples are not being collected for chemical analysis at most of the proposed monitoring well locations. Where soil sample will be collected for chemical analysis, the procedure will be the same as described for sampling for DPT samples, *items iv* through *ix* under *Direct-Push Technology (DPT)* above, except that only one set of Encore samples will be collected from a 2-foot sample, to be collected in the center (lengthwise) of the sample. Whether or not samples are obtained for chemical analysis, headspace readings will be taken from each sample as described under *Direct-Push Technology (DPT)* above, *item vi*.

Soil samples will be collected with the rotary drill rig using the following procedure:

i) A new pair of disposable nitrile gloves will be donned for handling each sample. The gloves should be changed any time during sample collection when their cleanliness is compromised.

ii) Prior to use at each sampling location, all sampling equipment will be decontaminated in accordance with the methods specified in SOP 1.

iii) A 2-foot long stainless-steel solid or lined split spoon sampler will be advanced through the designated sampling interval in accordance with ASTM D1586-08

Standard Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils, as described under *Other Procedures,* below*;* or, if this standard has been updated, with the most recent version of this standard.

iv) The split-spoon sample will be retrieved by removing the drill rods and sampler from the borehole.

v) Always discard the top several inches of material in the slit spoon before removing any portion for sampling. This material normally consists of borehole wall material that has sloughed off of the borehole wall after removal of the drill string prior to and during inserting the split spoon.

Note: If visual signs of contamination or elevated PID head-space monitoring are encountered during borehole advancement a grab sample may be collected from this interval.

In the event a HSA advanced borehole requires closure, the borehole will be grouted as described under *Direct-Push Technology (DPT)* above, except that the grout will be installed using a tremie pipe placed near the base of the borehole. The tremie pipe will be withdrawn as the borehole is filled with grout, while keeping the tip of the pipe submerged. It is not necessary to use a side discharge pipe. Prior to leaving the abandoned borehole, ensure that the stake marking the sample location has a clearly legible identifier and is securely in the ground so that it can be accurately surveyed.

Fluids generated will be transported to the liquid IDW storage tanks and drill cuttings will be transported to the solid IDW roll-off box or 55-gallon drums. Temporary storage containers used shall have a lid used during transport. Proper precautions will be taken to prevent releases of fluids/solids to the ground during transportation or transfer.

OTHER PROCEDURES

A. Standard Penetration Testing (SPT) Sampling and Testing Procedure

Once the borehole is advanced to the target depth and the borehole cleaned of cuttings, representative soil samples are collected in the following manner:

- the split-spoon sampler should be inspected to ensure it is properly cleaned and decontaminated. The driving shoe (tip) should be relatively sharp and free of severe dents and distortions;
- the cleaned split-spoon sampler is attached to the drill rods and lowered into the borehole. Do not allow the sampler to drop onto the soil;
- after the sampler has been lowered to the bottom of the hole, it is given a single blow to seat it and make sure that it is in undisturbed soil. If there still appears to

be excessive cuttings in the bottom of the borehole, remove the sampler from the borehole and remove the cuttings; and

- mark the drill rods in three or four successive 6-inch increments, depending on sampler length, so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-inch increment.

The sampler is then driven continuously for 24 inches by use of a 140-pound hammer. The hammer may be lifted and dropped by either the cathead and rope method, or by using a trip, automatic, or semi-automatic drop system. The hammer should free-fall a distance of 30 inches (±1 inches) per blow. To ensure a free-falling hammer, no more than 2 1/4 turns of the rope may be wound around the cathead (see ASTM D1586). The number of blows applied in each 6-inch increment is counted until one of the following occurs:

- a total of 50 blows have been applied during any one of the 6-inch increments described above;
- a total of 100 blows have been applied;
- there is no advancement of the sampler during the application of ten successive blows of the hammer (i.e., the spoon is "bouncing" on a stone or bedrock); or
- the sampler has advanced the complete 24 inches without the limiting blow counts occurring as described above.

In some cases where the limiting number of blow counts has been exceeded, the site geologist may direct the driller to attempt to drive the sampler more if collection of a greater sample length is essential.

On the field form, record the number of blows required to drive each 6-inch increment of penetration. The first 6 inches is considered to be a seating drive. The sum of the number of blows required for the second and third 6 inches of penetration is termed the "standard penetration resistance" or the "N-value."

The sampler is then removed from the borehole and unthreaded from the drill rods. The open shoe (cutting end) and head of the sampler are partially unthreaded by the drill crew and the sampler is transferred to the geologist/engineer work surface.

The open shoe and head are removed by hand, and the sampler is tapped so that the tube separates.

Measure and record the length of sample recovered making sure to discount any sloughed material that is present on top of the sample core.

B. Soil Descriptions

Depths should be recorded in feet and decimal fractions thereof (tenths of feet). Field estimates of soil classifications shall be in accordance with ASTM Standard Practice D 2488 and shall be prepared in the field at the time of sampling by the site geologist. Guidance on soil and rock classification may also be found in the Department of Army EM 1110-1-1906, which is available electronically on the internet.

The description for natural undisturbed soil is recorded on the Log of Soil Boring. Descriptions are completed in the following order:

i) classification (e.g., sandy clay)

ii) geologic classification (e.g., loess or glacial till)

iii) Unified Soil Classification System (USCS, ASTM D 2488) group symbol(s) (e.g., SM) of primary soil components or dual and borderline symbols

iv) secondary components and estimated percentages (e.g., sand 25%, with 5 percent fine sand and 20 percent coarse sand)

v) relative density (for non-cohesive soil) or consistency (for cohesive soil)

vi) gradation and soil structure (for non-cohesive soil) or structure and plasticity (for cohesive soil) (e.g., bedding, presence and orientation of fractures, etc.)

vii) color

viii) moisture condition (dry, moist, wet or saturated)

ix) other physical observations such as presence of stains or odors.

> ***Note:*** When describing vegetative matter presence in the soil column, do not use the term "organic" as this often leads to confusion with regards with organic chemical (i.e., NAPL) presence.

The description of fill soil is similar to that of natural undisturbed soil except that it is identified as fill and not classified by USCS group, relative density, or consistency (i.e., SP/GP-Sand and Gravel (Fill)).

It is necessary to identify and group soil samples consistently to determine the subsurface pattern or changes and non-conformities in soil stratigraphy in the field at the time of drilling. The stratigraphy in each borehole during drilling is to be compared to the stratigraphy found at the previously completed boreholes to ensure that pattern or changes in soil stratigraphy are noted and that consistent terminology is used.

Visual examination, physical observations and manual tests (adapted from ASTM D2488, visual-manual procedures) are used to classify and group soil samples in the field and are

summarized in this subsection. ASTM D2488 should be reviewed for detailed explanations of the procedures. Visual-manual procedures used for soil identification and classification include:

- visual determination of grain size, soil gradation, and percentage fines;
- dry strength, dilatancy, toughness, and plasticity (thread or ribbon test) tests for identification of inorganic fine grained soil (e.g., CL, CH, ML, or MH); and
- soil compressive strength and consistency estimates based on thumb indent and pocket penetrometer (preferred) methods.

The three main soil divisions are: coarse grained soil (e.g., sand and gravel), fine grained soil (e.g., silt and clay), and soil with high natural organic matter content (e.g., peat and marl).

Coarse Grained Soil

The USCS group symbols for coarse grained soil are primarily based on grain or particle size, grain size distribution (gradation), and percent fines (silt and clay content).

Coarse grained soil is made up of more than 50 percent, by weight, sand size, or larger (75 μm diameter, No. 200 sieve size or larger).

Descriptions for grain size distribution of soil include; poorly graded (i.e., soil having a uniform grain size, SP and GP) and well graded (i.e., poorly sorted; having wide range of particle sizes with substantial intermediate sizes, SW and GW).

Coarse grained soils are further classified based on the percentage of silt and clay they contain (fines content). Coarse grained soils containing greater than 12 percent fines are commonly described as dirty. This description arises from the soil particles that adhere when the soil is rubbed between the hands or adhere to the sides of the jar after shaking or rolling the soil in the jar. The jar shake test which results in segregation of the sand and gravel particles is also used as a visual aid in determining gravel and sand percentages.

Examples of the group symbol, name, and adjectives used to describe the primary, secondary, and minor components of soil are; GW - Sandy Gravel (e.g., 70 percent gravel and 30 percent sand) or Sandy Gravel trace silt (less than 10 percent silt), and SP - Sand, uniform.

Relative density is an important parameter in establishing the engineering properties and behavior of coarse grained soil. Relative density of non-cohesive (granular) soil is determined from standard penetration test (SPT) blow counts (N values) (after ASTM Method D1586).

The SPT gives a reliable indication of relative density in sand and fine gravel. N values in coarse grained soil are influenced by a number of factors that can result in overestimates of relative density (e.g., in coarse gravel and dilatent silty fine sand) and can be conservative and underestimate the relative density (e.g., sand below the groundwater table and uniform coarse

sand). These effects will be assessed by the project geotechnical engineer, if required, and need not be taken into account by field personnel.

Other dynamic methods, such as modified SPT and cone penetration tests, are used on occasion to supplement or replace the SPT method for certain site-specific conditions. The details of all modifications to the SPT or substitute methods should be recorded as they are required to interpret test results and correlate to relative density.

Fine Grained Soil

A soil is fine grained if it is made up of half or more of clay and silt (i.e., fines greater than 50 percent by weight passing the 75 μm (No. 200) sieve size). A description of visual-manual field methods and criteria that are used to further characterize and group fine grained soil (e.g., CL, CH, ML, or MH) including dry strength, dilatancy, toughness, and plasticity (thread or ribbon test) follows.

CRITERIA FOR DESCRIBING DRY STRENGTH

Description	*Criteria*
None	The dry specimen crumbles into powder with mere pressure of handling.
Low	The dry specimen crumbles into powder with some finger pressure.
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
High	The dry specimen crumbles into powder with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface.

CRITERIA FOR DESCRIBING DILATANCY

Description	*Criteria*
None	No visible change in small wetted specimen when rapidly shaken in palm of hand.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing or stretching.

CRITERIA FOR DESCRIBING TOUGHNESS

Description	*Criteria*
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

CRITERIA FOR DESCRIBING PLASTICITY

Description	*Criteria*
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

RECORDED INFORMATION

During the advancement of the boreholes the following information will be recorded on the stratigraphic log or in the field book:

i. depth interval of each sample collected, classified, and/or retained;
ii. length of sampled interval, length of sample recovery, and the sampler type and size (diameter and length).
iii. blow counts, hammer type and weight, and length of hammer fall for driven samplers.
iv. Blow counts should be recorded in 0.5 ft increments when standard penetration (ASTM D 1586) samples are used.
v. Headspace PID reading, if taken. Each notation should include interval sampled and reading.
vi. Borehole advancement method and whether additives were used in the process.

FOLLOWUP ACTIVITIES

The following activities should be completed at the end of each day.

i) prior to leaving a work area make sure equipment and supplies are secure and the work area is cleaned up and secure,

ii) ensure field logbook and field forms have been updated and are complete,

iii) ensure soil sample locations have been re staked,

iv) allow sufficient time to package, log and ship samples.

v) ensure collected field data is properly logged and filed including photo documentation. Images should be uploaded to a computer and the electronic files named. Record the photo ID electronic files names on the Field Sampling Data Sheet. Ideally, the electronic properties of the files will have the Title field include the location identifier and the Description field include the orientation of the shot and subject description. The named photo files should then be electronically backed up on an external hard drive, CD, or other mass storage device. Quality control should be performed daily to ensure the images are clear and show the intended features. Some general photographs should also be taken to document sampling collection methodology and activities during the field effort.

*It is not sufficient to write in the logbook "borehole installation and sampling (overburden) were done in accordance with the project SOPs." Rather, the logbook should detail the steps and materials used for all the requirements as noted above.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 4
SURFACE SOIL SAMPLING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

This SOP describes how to obtain surficial soil samples for chemical analyses. The primary goal of surface soil sampling is to collect representative samples for examination and chemical analysis (if required). Soil sampling techniques are dependent upon the sample interval of interest, the type of soil material, and the requirements for handling the sample after retrieval.

GENERAL

The U.S. FWS and the Respondent will attempt to pre-stake locations using maps, aerial photographs, and GPS units. However, in the event a location cannot be identified, it may need to be surveyed based on coordinates provided by the FWS and the Respondent prior to sampling.

If it is necessary to relocate any proposed borehole due to terrain, utilities, access, etc., notify the FWS representative. This person will in turn notify the Respondent. The FWS will determine appropriate action. Provide a 48-hour notice to the FWS if borehole relocation is necessary.

Document all deviations from the procedures required by this SOP in a standard bound field logbook (logbook). In addition, implement corrective action as described in Worksheets #6, #14, #31-1, and #32-1 of the Quality Assurance Project Plan (QAPP). If corrective action is not required, describe the basis for that determination in the logbook.

PRIOR PLANNING AND PREPARATION

Preparatory tasks for borehole installation and surface soil sampling:

i) Review the Work Plan, Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.

ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed.

iii) Obtain a site plan and review any existing stratigraphic information. Determine the exact number and location of surface soil samples for chemical analysis. Assemble sample containers if needed.

iv) Evaluate access conditions with the FWS representative to determine whether any vegetation needs to be cleared to access investigative locations. Coordinate required approvals of clearing activities with the FWS.

v) Establish a potable[1] water source for decontamination activities.

vi) Review procedures for the handling and disposal of wash waters, and spent decontamination fluids in SOP 11.

[1] Obtain potable water from a clean source and contain in a pre-cleaned poly tank.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 4
SURFACE SOIL SAMPLING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

EQUIPMENT NEEDS

Equipment required (additional equipment may be needed) to complete the tasks associated with this SOP:

- equipment decontamination supplies as noted in SOPs 1 and 2
- logbook
- stainless steel bowls, trowels and spoons
- air monitoring equipment
- PPE as specified in the HASP
- sample containers (sample container/preservative requirements are outlined in Table 3 of the FSP and Worksheet #19 of the QAPP)
- cooler and ice
- stainless steel hand auger and flights
- camera
- re-sealable baggies

EQUIPMENT DECONTAMINATION

Prior to use and between each borehole location, follow the equipment decontamination procedures outlined in SOPs 1 and 2.

FIELD PROCEDURE

Prior to surface soil sampling, photo document the sample location and surrounding area using a digital camera of 5 megapixels or better. Include two or more reference points to help relocate the sample location in the future. Record the date and time of photographs, shot orientation, description of the shot, and the camera operator in the field logbook.

Remove any surficial debris (i.e., grass cover) from the area where the sample is to be collected using a separate pre-cleaned device. In general, collect soil from below the thatch zone and remove excessive organic matter (roots, plant debris) before collecting the soil sample. In addition, avoid collecting samples with excessive amounts of large particles such as gravel. Gravel presents difficulties for the laboratory in terms of sample preparation and may not be truly representative of contaminant concentrations in nearby soil.

At locations where surface soil sampling activity is concurrent with subsurface borings, collect soil samples from the 0- to 6-inch and the 6- to 24-inch depth intervals using the procedures detailed in SOP 3.

Use DPT (either hand-driven or rig) or rotary drill rig as the preferred method to collect surficial soil samples. Collect samples following the site-specific protocols outlined in SOP 3; however,

do not obtain headspace readings for the 0- to 6-inch or the 6- to 24-inch depth intervals due to the limited volume of soil available. Alternative methods are necessary at remote locations inaccessible by DPT or drill rig.

Use the following surface soil sampling procedures at locations inaccessible to drill rigs:

i) Don a new pair of disposable nitrile gloves (or equivalent) for each sample. Change the gloves any time during sample collection when their cleanliness is compromised.

ii) Obtain a soil sample from the 0- to 6-inch depth interval using a pre-cleaned, stainless steel hand auger or stainless steel hand shovel. Place the soil sample in a pre-cleaned stainless steel bowl or tray. Complete *tasks v* and *vi* prior to performing *tasks iii and iv*.

iii) Decontaminate the equipment used between every sample interval as described in SOP 2.

iv) Advance the hand auger through the 6- to 24-inch depth interval and place the soil in a separate pre-cleaned stainless steel bowl. As hand augers generally retrieve soil in 6-inch intervals, advance the hand auger through three 6-inch intervals to obtain the 6- to 24-inch soil sample. Place the aliquots of soil from each 6-inch interval in a stainless steel bowl until the entire length is obtained. Do not delay between 6-inch intervals. Complete this activity in the shortest reasonable period.

v) Collect the soil sample(s) selected for VOC analysis in accordance with USEPA SW-846 Method 5035 using Encore or a similar piston-type sampler. Push the sampler into the soil within the pre-cleaned stainless steel bowl forcing the soil up and into the sampler. (This is the same general procedure as used to collect soil samples from split spoon and DPT samplers.) For the 6- to 24-inch depth interval, fill three samplers with soil. Recover approximately 15 grams of soil from each interval. Fill one 2- or 4-ounce jar per sample depth and send to the laboratory for percent moisture analysis. Immediately label the recovered soil samples, and place them into a cooler containing ice.

NOTE: some piston type volumetric sampling devices that are used in place of Encore™ samplers to meet the requirements of Method 5035 mav require a different sample volume, and field preservation with methanol, laboratory grade deionized water, and/or sodium bisulfate. Any field preservation is performed immediately following sample collection. The "ESS Lock n Load" system as specified in the ECCS Laboratory method SOP is a piston type volumetric sampler that measures a 10-gram undisturbed sample that is immediately preserved in methanol in the field (in a glass VOA vial)

vi) For non-VOC analysis, obtain soil samples from the 0- to 6-inch depth interval using a pre-cleaned stainless steel spoon, trowel, or hand shovel. Place a sufficient volume of soil to fill sample containers into a clean stainless steel bowl or tray and **thoroughly** homogenize the sample using a stainless steel mixing utensil. Use a container large enough to hold the sample volume and to

accommodate the procedure without spilling. In most cases, use the following cone and quartering method:

1. Mix sample to disaggregate soil to less than ¼-in. diameter.
2. Gather soil into a pile in the middle of the container and divide into quarters.
3. Mix each quarter, and then mix soils from opposite corners together.
4. Combine the whole, and divide into quarters again.
5. Mix each quarter, and then mix soils from adjacent corners together.
6. Combine the whole, and repeat steps 2-6 until a consistent physical appearance is achieved.
7. Divide the soil into final quarters, and equally subsample as described in *item vi*.

If the soil is not amenable to cone and quartering techniques due to its high moisture content or high cohesiveness, kneading techniques may be used. Place the sample into a clean noncontaminating bag then knead the soil thoroughly to mix[2].

vii) Split the sample among the laboratory-supplied containers using the alternative shoveling method. Place a spoonful of soil in each container in sequence and repeat until the containers are full or the sample volume has been exhausted. Label and place the containers in a cooler with ice.

viii) After sampling, if the borehole is no more than 2' bgs, fill it from the base to the ground surface with granular bentonite in 1-foot lifts, hydrating each foot with 3.5 cups of laboratory grade de-ionized water. Document the process in the field logbook including the amount of pellets and water used.

ix) Prior to leaving the abandoned borehole, ensure that the stake marking the sample location has a clearly legible identifier and is securely in the ground so that it can be accurately surveyed.

RECORDED INFORMATION

Document all conditions at the time of sample collection. Include the following in the field logbook:

- site location, date, time, and weather
- analyses requested for each sample
- depth of sample interval and sample identification (sample number)

[2] Homogenization procedures derived from the U.S. Army Corps of Engineers *Engineering and Design – Requirements for the Preparation of Sampling and Analysis Plans*, E200-1-3, 1 Feb 2001.

- thorough description of the sample characteristics including grain size, color, and general appearance
- any QA/QC sampling performed
- headspace PID reading, if taken
- equipment used to collect each sample
- PPE worn during sample collection and equipment decontamination
- description of equipment decontamination* procedures and confirmation the equipment used to collect samples was decontaminated between sample intervals
- name(s) of the sampler(s)

FOLLOWUP ACTIVITIES

Complete the following at the end of each day:

i) Ensure that equipment and supplies are secure and the work area is clean and secure prior to leaving a work area.

ii) Ensure the logbook is updated and complete.

iii) Ensure soil sample locations have been re-staked.

iv) Allow sufficient time to package, log and ship samples.

v) Ensure collected field data, including photo documentation, is properly logged and filed. Upload images to a computer and name the electronic files. Include the location identifier, orientation of the shot, and subject description as a part of the file's properties. Record the photo ID electronic file names on the Field Sampling Data Sheet. Backup the named photo files on an external hard drive, CD, or other mass storage device. Perform quality control daily to ensure the images are clear and show the intended features. Take some general photographs to document sampling collection methodology and activities during the field effort.

* It is not sufficient to write in the logbook "sample collection and decontamination were done in accordance with the project SOPs." Rather, the logbook should detail the steps and materials used for all the requirements as noted above.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 5
OVERBURDEN MONITORING WELL
CONSTRUCTION AND DEVELOPMENT
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

The following SOP presents the installation of new overburden monitoring wells during the field investigation. The total depth of the wells will vary depending upon the depth to the water table at each location. Details regarding borehole advancement and soil sampling for stratigraghic characterization are provided in SOP 3.

GENERAL

Prior to borehole advancement and monitoring well installation, the site geologist shall review existing site-specific geologic and hydrogeologic information.

Document all deviations from the procedures required by this SOP in a standard field logbook (logbook). In addition, implement corrective action as described in Worksheets #6, #14, #31-1, and #32-1 of the Quality Assurance Project Plan (QAPP). If corrective action is not required, describe the basis for that determination in the logbook.

PRIOR PLANNING AND PREPARATION

Preparatory tasks prior to borehole installation and subsurface soil sampling:

i) Review the Work Plan, Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.

ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed.

iii) Obtain a site plan and review any existing stratigraphic information. Determine the exact number and location of boreholes to be installed and the depths of samples for chemical analysis. Assemble sample containers if needed.

iv) Review with the FWS representative whether utility clearance activities have been completed in the areas where subsurface investigations are to be conducted.

v) Establish a water source for drilling and decontamination activities. Review procedures for handling and disposal of drill cuttings, wash waters, and spent decontamination fluids in SOP 11.

vi) Evaluate access conditions with the FWS representative to determine whether any vegetation clearing is necessary to access investigative locations and coordinate required approvals of clearing activities with the FWS.

EQUIPMENT NEEDS

Equipment required (additional equipment may be needed) to complete the tasks associated with this SOP:

- equipment decontamination supplies
- field logbook, field forms (hard copy or electronic)
- well development pumps
- water level meter
- portable electric power supply
- surge block/bailer
- polyethylene tubing and stainless steel fittings
- air monitoring equipment
- PPE as specified in the HASP
- cooler and ice
- 5-gallon buckets and or portable tanks
- water quality meters (pH, Conductivity, temperature, and turbidity)
- camera
- re-sealable baggies

FIELD PROCEDURE

A. Location and Marking of Drill Sites/Final Visual Check

The U.S. FWS and the Respondent will attempt to pre-stake locations using maps, aerial photographs, and GPS units. However, in the event a location cannot be identified, it may need to be surveyed in based on coordinates provided by U.S. FWS and the Respondent prior to sampling.

Once the final location for the proposed boring has been selected and utility clearances are complete, visually check the immediate area again before drilling. Confirm the locations of any adjacent utilities (subsurface or overhead), and verify there is adequate clearance. If gravity sewers or conduits exist in the area, open any access manholes or chambers and confirm the conduit/sewer alignments, if possible.

If it is necessary to relocate any proposed borehole due to terrain, utilities, access, etc., notify the FWS representative. This person will in turn notify both the FWS and the Respondent. FWS

will determine appropriate action. Provide a 48-hour notice to the FWS if borehole relocation is necessary.

Details regarding borehole advancement are provided in SOP 3, including photo documentation.

B. Equipment Decontamination for Environmental Sites

Prior to use and between each borehole location, follow the equipment decontamination procedures outlined in SOP 1 and SOP 2.

C. Permanent Overburden Monitoring Wells

Prior to well installation the site geologist (as defined in SOP 3) will review available information pertaining to geology and water levels of existing monitoring wells in the area. Details regarding borehole advancement are provided in SOP 3.

Prior to beginning each phase of well installation activity (overburden drilling and installation of well casing and screen), check the horizontal levelness of the drill rig in two perpendicular directions using a carpenter's level, and re-level if needed to ensure the drill rig is level horizontally. Check the first auger and well casing with a carpenter's level in two perpendicular directions to ensure that it is vertical before beginning drilling or installation. If not, adjust the drill rig until the noted item is vertical as measured by the carpenter's level. The site geologist shall note in the logbook that this work was done. The borehole should be close to vertical as possible.

Specific installation protocols for the permanent overburden monitoring wells are described below:

i) The screened interval for the monitoring wells should target the upper 10 feet of the water table. Advance the boreholes for monitoring wells to the target depth[1] using a rotary drill rig equipped with at least 8-inch outer diameter (OD) 4.25-inch inner diameter (ID) hollow-stem augers (HSA). Refer to SOP 3 for borehole installation method. The ID must be of sufficient size to allow the passage of the tremie pipe for well grout placement, as well as free passage of filter sands or bentonite pellets dropped through the auger or casing. Collect soil samples in accordance with SOP 3.

ii) Before the well screen and casings are placed on the bottom of the borehole, place at least 6 inches of filter material at the bottom of the borehole to serve as a firm footing. For water table wells, attach a 10-foot nominal 2-inch diameter 0.010-inch machine slotted type 316 stainless steel no. 10 slot well screen to a

[1] Install water table wells so the screen interval captures available historic water levels if possible (see Table 1 of the Work Plan); however, *item iii* below indicates the top of the screen cannot be shallower than 7 feet bgs.

10-foot flush-threaded type 316 stainless steel riser and lower into the annulus of the HSA. For wells screened below the water table, use the same materials and procedure except with a 5-foot well screen. All well casings and screens (including the 6" outer casing) should be free of foreign matter (e.g., adhesive tape, labels, soil, grease, etc.) and decontaminated per SOP 2. Store washed casings in clean unused plastic sheeting until immediately prior to insertion into the borehole. Prewashing may not be necessary if the materials have been packaged by the manufacturer and certified as clean and have their packaging intact up to the time of installation. Remove any writing on the casing or screen prior to installation using a scrub brush or pad, and decontaminate pursuant to SOP 2. No fitting should restrict the ID of the joined casing or screen. Use new screens, casings, and fittings. Except where groundwater is very shallow (see *item iii* below), attach two-inch diameter flush-threaded schedule 40 PVC riser pipe to the stainless steel riser in 10-foot increments as the assembly is lowered into the borehole. Ensure the assembly is plumb using a level and plumb bob. The driller shall set the well (riser and screen) under tension until the sand pack has been set to maintain vertical plumbness. Place the string of the well screen and casings into the borehole and plumb. (All PVC risers and fittings should conform to National Sanitation Foundation (NSF) Standard 14 for potable water usage or ASTM Standard Specification F 480 and bear the appropriate rating logo.) Continue this procedure until the bottom of the screen has reached the base of the borehole and there is a sufficient length of riser pipe to extend above the ground surface. Use PTFE tape to wrap the threads to insure a tight fit and minimize leakage. Do not use lubricating oils or grease on casing threads. Do not use glue of any type to secure casing joints.

iii) At locations where the water table is shallow (less than 10 feet below ground surface), place the well screen to a sufficient depth to allow for installation of the sand pack (2 feet above the top of the screen), bentonite pellet seal (2 feet above the top of the sand pack), and concrete surface seal (3 feet below ground surface). The site geologist should ensure that a stainless steel riser is used below ground surface.

iv) After the well screen string and casing is plumb, place the filter material around the well screen (by the tremie method in open boreholes) up to the designated depth. When installing the well screen and casings through hollow-stem augers, extract the augers slowly as the filter pack, bentonite seal, and grout are tremied or poured into place. The gradual extraction of the augers will allow the materials to flow out of the bottom into the borehole. Place a slipcover over the top of the pipe to prevent foreign particles from entering the well annulus during auger removal. (Note: Some 5-foot screens will be available.)

v) Add the filter sand pack while the well is under tension to ensure vertical plumbness. The filter sand pack should consist of clean washed, well-rounded silica sand of a gradation appropriate for the screen and the formation (20-40 gradation or equivalent). Granular filter packs must be visually clean (as seen through a 10-power hand lens), and free of material that would pass through a

No. 200 (75 µm [0.0029 in.]) sieve. Organic matter or soft, friable, thin, or elongated particles are not permissible. The filter material should be packaged in bags by the supplier and therein delivered to the site. Submit a one-pint representative sample for visual familiarization of each proposed granular filter pack to the FWS a week prior to drilling for approval. Describe each sample in writing in terms of lithology, grain size distribution, brand name, source (both manufacturing company and location of pit, quarry, or origin), processing method (e.g., pit run, screened and unwashed, screened and washed with water from river, pond, etc.), and chemical analysis. Extend the filter sand pack 6 to 9 inches below, and 2.5 to 3 feet above the top of the screen to allow for settling and to isolate the screened interval from the grouting material. If necessary, install the sand using a tremie pipe as the HSAs are removed to prevent bridging of the sand pack in the annular space between the borehole wall and the outside of the well materials. If a tremie pipe is not used, measure the top of the sand pack frequently during installation and then at completion. Make measurements at various lateral locations around the screen and riser (not just at the same plan-view location). The drilling contractor shall measure the final depth to the top of the filter pack, using a weighted tape, and shall record the measurement in the logbook.

vi) Place a 2-foot thick seal (minimum) of 3/8-inch diameter bentonite pellets in the annular space above the filter pack sand. The drilling contractor should frequently measure the vertical distance to the top of the pellets using a weighted measuring tape during installation and at completion as the bentonite pellets are placed. Measurements should be made at various locations around the perimeter of the well casing. The final depth to the top of the pellet seal should be recorded in the logbook. If water is not present within the hole, constantly add laboratory grade deionized water throughout placement of the seal. If a high solids bentonite grout is used, place the pellets in 1-foot layers with each layer being allowed to hydrate a minimum of 30 minutes or per the manufacturer's recommended hydration time, which ever is greater, prior to continuing with well construction activities. If a cement/bentonite grout is used, place the pellets in 1-foot lifts with a minimum hydration time per lift of 60 minutes, and a total minimum hydration time of 4 hours. If the activities are toward the end of the day, allow the bentonite seal to hydrate overnight. Place the bentonite seal immediately after installing the filter pack, unless initial development is warranted (to seat the filter pack) prior to placement of the seal, in which case the seal should be placed immediately upon completion of the initial development.

vii) Fill the annular space between the well riser and the borehole wall with either a high solids bentonite grout or a cement/bentonite grout from the top of the bentonite pellet seal to the ground surface. Do not use high solids bentonite grout in areas suspected as DNAPL source areas. Combine all prescribed portions of grout material in an aboveground rigid container and mechanically (not manually) blend to produce a thick, lump-free mixture throughout the

mixing vessel. For the cement/bentonite grout, use a grout mix ratio of 94 lbs of Type I Portland cement, 4 to 5 lbs of bentonite, and 8 to 9 gallons of potable water. Use separate marked containers for each constituent (bentonite, water, and cement (if the entire 94 lb bag is not used)) that allow for measurements with these ranges of precision. Bentonite grout should be a 30% solids pure bentonite grout with a minimum density of 10 pounds per gallon (lb/gal). Measure the density of the first batch while mixing to verify proper measurement of ingredients. In addition, do not cease the grouting operation until the bentonite grout flowing out of the borehole has a minimum density of 10 lbs/gal. Use a mud balance to measure the specified grout density. Estimating the grout density is not acceptable. In general, since the wells are shallow and the depth to the top of the bentonite seal is less than 15 feet, simply pour the grout mixture into the annulus. However, if there is more than 1 foot of standing water above the bentonite seal after hydration, or if the depth from the ground surface to the top of the bentonite seal is more than 15 feet, place the grout in the well annulus with a 1-inch ID (or smaller) side-discharge tremie pipe. Keep the bottom end of the tremie pipe submerged throughout the grouting process. The bottom of the pipe may be raised as the hole is filled, but should remain below the surface of the grout. Incrementally remove the HSAs with intermittent grout addition. If the ungrouted portion of the hole is less than 15 feet deep and without standing water after casing removal, the ungrouted portion may be filled by pouring grout from the surface without a pipe. Once begun, continue the grouting process until all the HSAs have been removed and all the annular spaces have been grouted. The site geologist shall record in the logbook the weights and measures of the grout ingredients, and the total amount of grout added to the borehole.

viii) Place the outer casing using a concrete mix that meets or exceeds the requirements of ASTM C387, with a minimum 7-day compressive strength of 2500 psi. Do not use fast setting concrete. Use Type 1 Portland cement meeting the requirements of ASTM C150 -07 (or the most recent version). Mix and install the concrete according to the manufacturer's directions, and provide these directions to the FWS prior to use.

ix) Install an outer protective casing into the borehole after the annular grout has cured for at least 24 hours. The protective casing should be 6-inch ID, 5-foot long, pre-painted (with yellow oil-based paint) steel, with a lockable cover. The lockable cover should either be hinged or be a loose-fitting telescopic slip-joint cap. The cover should be designed to keep direct precipitation and cover runoff out of the casing. All painting of the protective casing must be done offsite, prior to installation, and the paint must be dry when delivered to the site. Only the outside of the casing should be painted. Place concrete on top of the grout in the borehole to install the protective casing. Push the protective casing into the wet concrete and borehole a minimum of 2 feet, leaving approximately 3 feet above the ground surface. If necessary, add additional concrete to fill the inside of the protective casing so that all parts of the surface of the concrete inside of the

protective casing are above the highest point of the surface pad. After the cement has cured for at least 24 hours, horizontally cut the well riser to its final length forming a right angle to the long direction of the casing using a pipe cutter. The riser pipe, when installed and grouted, should extend above the ground surface a minimum of 2.5 feet. Place a well number and the installation date on the outside of the well casing to permanently identify the well. Various methods of identification have been successfully used such as painting the number on the protective casing with the help of a painting stencil, attaching a metal imprinted noncorrosive metal tag, or imprinting the number directly on the steel protective casing. Install a concrete surface pad around the outer casing with a minimum thickness of 6-inch, a minimum radius of 1.5-foot (3-foot diameter) from the protective cover, and a minimum depth of 30 inches below the ground surface around the outer casing, within the borehole. Concrete should be the same as specified in *item viii* above. Install the concrete, (including the concrete to water mixture) in accordance with the manufacturer's directions, which should be provided to FWS prior to use. Slightly slope the pad radially away from the outer casing so that drainage will flow away from the protective casing and off the pad. A minimum of 1-inch of the finished pad should be below grade to prevent washing and undermining by soil erosion. Embed a brass survey disk of 2" or greater in top of the concrete. This brass disk will be used by the surveyor to punch a mark and stamp the elevation and well number. Drill ¼-inch diameter weep holes (minimum two at 180 degrees apart) no more than 1/8 inch above the lowest level of the concrete inside the casing. Alternatively, a flush-mount lockable roadway box (depending on location-specific conditions) may be installed over the well. Fill a portion of the annulus between the protective casing and riser pipe with pea gravel to ensure the riser is centered within the casing. From the date of casing installation, secure the cover or cap to the casing by means of a noncorrosive padlock. All padlocks will be opened by the same key. The FWS will provide the number for the master locks.

x) Use a knife or saw to make a thin vertical notch on top of the well riser pipe before the coordinates and elevation survey is conducted and prior to any development or sampling activities. This should occur immediately after completion of well installation. This will serve as the reference point for the elevation survey and future hydraulic monitoring activities. The reference point must be clearly notched on the riser to ensure consistent readings are obtained from event-to-event and to minimize future measurement errors. To prevent filings from entering the well, place a clean unused paper towel into the top of the well riser pipe prior to notching. Make the notch on the north side of the well unless the riser is uneven in that direction or the north side is not easily accessible for measurements. Denote the notch with permanent marker in order to readily identify the location. Fit the well riser with a vented cap with an identification tag that identifies the well.

xi) Install four new concrete-filled steel guard posts around the perimeter of the monitoring well (above grade wells only), and concrete in place. The posts should be at least 3 inches in diameter, pre-painted with yellow oil-based caution paint, and filled to above the top with concrete. The concrete and procedures are the same as for the pad. Install the guard posts to have a minimum depth of 30 inches and a minimum height of 4 feet above the ground surface. Distribute the posts evenly around the well and outside the pad, at least three feet from the well. Do not use soil or dry cement to fill the steel guard posts.

Transport drilling fluids to the liquid IDW storage tanks and drill cuttings to the solid IDW roll-off box. Use a lid during the transport of temporary storage containers. Take proper precautions to prevent releases of fluids or solids to the ground during transportation or transfer.

Note: The site geologist should plan activities such that well installation through placement of the bentonite seal can be completed on the same day that the work is commenced. However, circumstances may arise that delay the installation activities until the following days. In addition, well installation or drilling activities may be interrupted at anytime when severe weather conditions (i.e. lightning) are present. Issues regarding safety take precedence over any schedule related issues.

D. Permanent Monitoring Well Development

Well development establishes good hydraulic communication with the water-bearing unit and reduces the volume of sediment in the monitoring wells. Develop newly installed monitoring wells no sooner than 24 hours and no later than 7 days after surface pad and protective casing installation. In addition, develop newly installed and selected existing monitoring wells at least 3 days prior to groundwater sampling or measurements.

Well development procedures are as follows:

i) Place plastic sheeting around the well.

ii) Measure the depth to water and total well depth prior to development.

iii) Surge the screened interval of the monitoring well using a pre-cleaned surge block or bailer of an appropriate diameter (slightly smaller than the screen diameter and not large enough to damage the screen) for 10 to 20 minutes.

iv) Purge the monitoring well using a stainless steel cased electronic or pneumatic submersible pump.

v) Measure the pH, temperature, turbidity, and conductivity of the purged water initially and then at regular intervals using field instruments. Calibrate these instruments daily according to the manufacturer's specifications or QAPP specifications. Additionally, record observations such as color, odor, recharge and turbidity of the purged water. (Measurements for DO and redox are not

measured during well development as these parameters cannot be accurately measured during the development process.)

vi) Continue development (surging followed by purging) until the turbidity and silt content of the monitoring well is significantly reduced and three consecutive and consistent readings of pH, temperature, and conductivity are recorded, and there is 0.1 foot or less of sediment thickness remaining within the well. or a minimum of three times the standing water volume in the well is removed. Include the well screen and casing plus the saturated annulus within the sand pack, assuming 30 percent annular porosity. The standing water volume (V) in gallons for a 2-inch diameter screen and riser in an 8-inch diameter boring is calculated as follows. For the screen and riser only, V= 0.16H, where H is the total standing water height in feet. For the annular space only, V = 0.73H, where H is the standing water height in feet within the sandpack portion of the well. Add the volume of the screen and riser only, plus the volume of the annular space within the sandpack. The minimum removal in gallons is 3V. If any water was added to the well during installation, then three times the amount of any water unrecovered from the well during installation should be removed (in addition to three times the standing volume).

vii) In the event that a monitoring well is purged dry prior to the removal of five well volumes, purge the well dry three times. If slow/poor recovery rates are encountered (i.e., purged dry), a pre-cleaned stainless steel bailer may be used to complete the development.

viii) If the well is pumped to dryness or near dryness (which is likely at the site), allow the water table to sufficiently recover (to the static water level) before initiating the next development period.

ix) Three consistent readings for pH, temperature, and conductivity are defined for the purpose of monitoring well development as three consecutive readings within 5 percent of the median of the last three readings.

x) If the water remains turbid, the formation soils may have not been washed out of the borehole. Continuous flushing over a period of several days may be necessary to complete the well development.

xi) Measure the water level and total depth following well development.

Development data will be documented in the field on standard Well Construction Diagram forms and/or in the field logbook. Alternately, electronic forms may be used. If only electronic forms are used, forms must be completed in the field when the work is done. Information noted below that is not included on the Well Construction Diagram form will be noted in the logbook. Information to be recorded on the Well Construction Diagram and/or field book includes:

i) project name, location, well designation

ii) location, date and time of well installation (as recorded on the well instrumentation log)
iii) date and time of well development
iv) static water level from top of well casing before and 24 hours after development,
v) quantity of water lost during drilling, removed prior to well insertion, lost during thick fluid displacement, added during granular filter placement, quantity of fluid in well prior to development and standing in -well contained in saturated annulus (assume 30 percent porosity)
vi) field parameter measurements,
vii) depth from top of well casing to bottom of well,
viii) screen length
ix) depth from top of well casing to top of sediment inside well before and after development (from actual measurements at time of development)
x) physical character of removed water, to include changes during development in clarity, color, particulates, and any noted odor
xi) type and size/capacity of pump and or bailer used, description of surge technique, if used
xii) height of well casing above ground surface (from actual measurement at time of development)
xiii) typical pumping rate estimated recharge rate
xiv) quantity of fluid/water removed and time for removal.

RECORDED INFORMATION

Details of each overburden well installation should be recorded on the Log of Soil Boring and recorded in the logbook. Well Construction Diagram is used for recording the overburden well instrumentation details, this figure will note:

- borehole depth and diameter
- well screen interval location from ground surface
- joint locations of outer pipe and well casing
- filter pack interval (both below and above screen) from ground surface
- bentonite seal interval location from ground surface
- grout interval location from ground surface for well casing
- surface cap detail
- screen and casing material
- outside diameter, nominal inside diameter, schedule/thickness, composition manufacturer of the well casing/risers
- screen slot size, slot configuration, outside diameter, nominal inside diameter schedule/thickness, composition, manufacture
- well diameter
- actual quantity and composition of filter pack material
- actual quantity and composition of seal
- actual quantity and composition of grout

- method used to center borehole and casing
- special problems and their resolutions; e.g. grout in wells; lost casing and/or screens, bridging, casing repairs or adjustments, etc.
- height of concrete inside protection casing relative to height of pad outside of casing
- documentation that the following were installed, and if not, why not: cap and lock, protective posts and their configuration, drainage ports, surface pad
- stick-up/flush-mount detail
- date and times for the start and completion of well installation
- water level 24 hours after completion with date and time of measurement
- date the well was notched
- date the well was surveyed

Manufacturer information associated with the materials used to construct the monitoring wells will be maintained in the main field book in the field office. If during the field investigation materials from different manufacturers are used this information will be noted.

FOLLOWUP ACTIVITIES

The following activities should be completed at the end of each day.

i) Prior to leaving a work area, make sure equipment and supplies are secure and the work area is cleaned up and secure
   ii) ensure field book and field forms have been updated and are complete
   iii) ensure the completed well has been locked and labeled
   iv) allow sufficient time to package, log and ship samples
   v) ensure collected field data is properly logged and filed

*It is not sufficient to write in the logbook "well installation was done in accordance with the project SOPs." Rather, the logbook should detail the steps and materials used for all the requirements as noted above.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 6
GROUNDWATER AND FLUID LEVEL MONITORING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

The measurement of fluid levels (groundwater or phase-separated fluids) in monitoring wells will be performed during the field investigation. Gauging will be performed at existing and newly installed monitoring wells at the Refuge. In conjunction with groundwater level measurements, surface water (e.g., ponds, lakes, rivers, and lagoons) levels will be monitored. This information is critical in understanding the hydrogeologic setting of the site and how contaminants may move beneath the site.

GENERAL

In order to provide reliable data, water levels must be collected over as short a period as possible. Groundwater level measurements will be collected during the first round of groundwater sampling and then remeasured every six months. The measurements (including staff gauge measurements) will be collected, if possible, on the same day and within as short of a period as possible within adjacent groupings of the PEST AUS area.

Because barometric pressure can affect groundwater levels, note significant weather changes during the period of water level measurements. Note if any of these controls are in effect during the groundwater level collection period. Due to possible changes during the groundwater level collection period, ensure that the time of data collection at each station is accurately recorded.

Document all deviations from the procedures required by this SOP in a standard bound field logbook (logbook). In addition, implement corrective action as described in Worksheets #6, #14, #31-1, and #32-1 of the Quality Assurance Project Plan (QAPP). If corrective action is not required, describe the basis for that determination in the logbook.

PRIOR PLANNING AND PREPARATION

The following activities must be undertaken prior to undertaking fluid level monitoring:

i) Review the Work Plan, Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.

ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed, and note such in a bound field logbook (logbook).

iii) Determine the exact number and location of water-level measurements and plan route to optimize collection activities.

iv) Double check previous water level and well construction records to ensure the proper locations are being monitored.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 6
GROUNDWATER AND FLUID LEVEL MONITORING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

EQUIPMENT NEEDS

The following is a general list of equipment, which will likely be required to complete the tasks associated with this SOP. This is a general list of equipment; additional equipment may or may not be required for any specific task.

- equipment decontamination supplies including a phosphate-free detergent and potable[1] water mix, and organic-free water (See SOP 2, pg 4)
- bound field logbook, field forms (hard copy or electronic)
- water level meter
- air monitoring equipment
- PPE as specified in the HASP
- 5-gallon bucket
- camera
- task specific documents and maps
- clean unused plastic sheeting

FIELD PROCEDURES

Once the prior planning and preparation activities are completed, proceed with fluid level measurements. The typical series of events which will take place are:

i) well identification/inspection
ii) air monitoring
iii) reference point determination
iv) level measurements
v) equipment decontamination and a description of such in the logbook
vi) field note completion, review, and checking
vii) equipment return
viii) documentation submitted to appropriate staff and files

Note: Fluid level measurements should follow a logical order from the least known or suspected level of contamination to the greatest. This will minimize the potential for cross-contamination between wells/monitoring locations.

[1] Potable water will be obtained from a clean source and will be contained in a pre-cleaned poly tank.

A. Well Identification/Inspection

Once at the site and prior to fluid level measurements, confirm that the well to be measured has been correctly identified and located. Numerous wells and well clusters are present at the Refuge such that identification errors can easily occur. Be alert to potential cap switching, mislabeled locations or unlabeled wells.

Compare well log details to measured well details (i.e., total well depth, casing diameter, casing stick-up or stick-down distances), field ties, and site plans to determine proper well locations.

Once the correct monitoring well is identified, complete a thorough inspection, and record in the field logbook. Determine if the cap and lock are secure or if they have been tampered with. If the well is unlocked, replace the lock. Note any cracks in the protective casing or surface seal, as well as any subsidence or surface water ponding in the vicinity of the well.

Note the results of the well inspection (even if the well is in perfect condition) in the logbook and/or Well Inspection Form, and inform the FWS representative of any well repairs required. Arrange to have any unmarked wells permanently marked with the well ID designation for proper identification. (A temporary marking at the time of inspection should also be performed.)

B. Air Monitoring

Prior to opening the well cap, measure the gas and vapor levels in the breathing space above the well casing with a photoionization detector (PID) to establish baseline levels. Repeat this measurement once the well cap is opened. If either of these measurements exceeds any of the air quality criteria established in the HASP, then proper respiratory protection will be required.

C. Reference Point

1. Field Personnel

Fluid level measurements are made relative to a surveyed reference point. For groundwater level measurements, the reference point is the notch point (usually located on the north side) on the top of the well riser. The top of the well riser should be level.

It is the responsibility of the well installer to ensure the top of the riser is level and the riser has a thin vertical notch made by a knife or saw for accurate surveying (see SOP 5). If no notch is present when fluid level measurements begin, contact the FWS representative for instruction since the surveyed reference point will have to be researched and the well riser will have to be notched before water level measurements can be collected from that well.

2. Surveyors

Survey the notch already placed on top of the monitoring well riser pipe by field personnel. If no notch is present, contact the FWS representative for further instructions since fluid level measurements may have already been taken from that well and research will be needed to determine, if possible, the point on the riser from where water measurements were collected.

Survey the elevation of this measuring point to an accuracy of 0.01 feet. Also, Survey the ground surface elevation to determine the actual stick-up height. Punch a mark in the brass disk in the top of the concrete monitoring well pad and stamp the elevation and well number. Record the survey information and the date of survey in a logbook.

D. Fluid Level Measurements

Measure the distance from the top of the riser pipe to the top of the water column using an electronic water level meter. Measure the depth to water from a fixed reference point (notch) on the well casing. Measure the water level to ±0.01 foot accuracy. Record the depth to groundwater measurements in the field logbook and on the monitoring well gauging log form. An electronic form may be used.

The following sections describe the most common techniques used to measure fluid levels.

1. Electronic Water Level Indicators

The most common method of obtaining water level measurements is with the electronic water level indicator (e.g., Solinst meter or Slope Indicator). These meters consist of a calibrated cable or tape with a weighted sensing tip at one end. When the tip contacts the water, an electric circuit is completed and a light, buzzer, or both signal the contact. Use the following procedure with electrical water level meters:

i) Check the proper operation of the meter by inserting the tip into water and noting if the contact is registered clearly. Always check to see if the tape has been previously repaired and if a correction of the measurement is required.

ii) Dry the tip and then slowly lower the tip into the well until contact with the water is indicated.

iii) Slowly raise the tip until the light or buzzer just begins to activate. This indicates the static water level.

iv) Using the thumb and index finger, grasp the tape at the reference point, and note the reading (to the nearest one-hundredth of a foot).

vi) The reading should be checked two times before removing the tape from the well to ensure accuracy.

vii) Record the water level measurement in the field logbook and water level form. Compare to previous measurements to see if significant changes (i.e., greater than 2 feet) have occurred. Recheck water level if a significant difference is measured.

viii) Once the water level has been measured, lower the water tip of the meter to the base of the well and record the total depth of the well.

ix) Record the total measurement in the field logbook and water level form. Compare to previous measurements to see if significant changes have occurred. Total depth measurements will be used to determine if well redevelopment may be required.

x) Decontaminate the entire portion of the tape that enters the well, including the tip in accordance with the protocols in SOP 2.

2. Interface Probe

In the event Light Non-Aqueous Phase Liquids (LNAPL) or Dense Non-Aqueous Phase Liquids (DNAPL) are encountered or suspected during the field investigation, use an interface probe to measure the surface of LNAPL layers and the interface between LNAPL and groundwater or groundwater and DNAPL. Electrical water level indicators are not reliable when phase-separated liquids are floating on the water surface.

The interface probe uses an optical liquid sensor, in conjunction with an electric circuit to detect the top of a phase-separated liquid and the interface between the phase layer and water (water level). The procedure for use of this probe is:

i) Lower the probe tip into the well until a continuous beep is heard (this indicates the top of the phase-separated liquid has been detected). Grasp the calibrated tape at the reference point and note reading. Confirm the reading by slowly raising and lowering the probe to the level of the phase layer. (Water is indicated by a discontinuous sound).

ii) Once the top of the phase layer is confirmed, slowly lower the probe until a discontinuous sound is heard. This indicates that the water level has been encountered. Grasp the tape at the reference point and note the reading. Confirm this water level measurement.

iii) Decontaminate the submerged end of the tape and probe prior to the next use in accordance with the protocols described in SOP 2.

E. Surface Water Gauging

Install staff gauges in water bodies during the field investigation as needed to record water level elevations. The staff gauges will consist of a surveyed fixed reference point located above the water body from which the distance to the top of the surface water body can be measured using a calibrated electronic water-level meter. Such points could include a bridge deck spanning the surface water body or a metal post driven into the bottom of the surface water body.

Record the distance from the surveyed reference point and the top of the surface water body to the nearest 0.01 foot using the calibrated electronic water-level meter when groundwater levels are monitored. Subtract the measured distance from the reference point to the top of the surface water body from the surveyed elevation of the reference point to determine the elevation of the surface water at the staff gauge location.

Record staff gauge measurements on the monitoring well gauging log form.

RECORDED INFORMATION

Record the fluid levels in a standard bound "survey" type field logbook and/or a Water Level Data Form. Record the following:

- identification of measurement point
- date and time of measurement
- weather conditions including temperature
- monitoring location condition
- reference point and reference point elevation
- measurement method (type of water level used)
- depth to water level
- total depth of well
- any calculations made such as well volumes
- presence and depth/thickness of phase-separated liquids
- odor (if noted)

It is not sufficient to write in the logbook "groundwater and other fluid level monitoring were done in accordance with the project SOPs." Rather, the logbook should detail the steps and materials used for all the requirements as noted above.

FOLLOW-UP ACTIVITIES

Complete the following activities at the end of each day:

i) Prior to leaving a work area make sure equipment and supplies are secure and the work area is cleaned up and secure.

ii) Ensure field logbook and field forms have been updated and are complete.

iii) Ensure the monitoring locations have been locked.

iv) Return keys and cleaned equipment to the main staging area.

v) Ensure collected field data are properly logged and filed.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 7
GROUNDWATER SAMPLING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

GENERAL

One of the most important aspects of groundwater sampling is acquiring samples that are free of suspended silt, sediment, or other fine-grained particulates. Fine-grained materials may often have a variety of chemical components sorbed onto the particle or have the ability to sorb chemicals from the aqueous phase to the particle that will bias the subsequent analytical results.

Document all deviations from the procedures required by this SOP in a standard bound field logbook (logbook). In addition, implement corrective action as described in Worksheets #6, #14, #31-1, and #32-1 of the Quality Assurance Project Plan (QAPP). If corrective action is not required, describe the basis for that determination in the logbook.

PRIOR PLANNING AND PREPARATION

Consider the following prior to groundwater sampling:

i) Review the Work Plan, Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.

ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition, calibrate as needed and note calibration details in a bound field logbook.

iii) Assemble site plan, well logs, and previous sampling/purging data that will be required for the planned sample event. Review holding times for various analytes. Determine the exact number and locations of the wells to be sampled.

iv) Contact the project chemist to arrange:

- laboratory
- glassware
- preservatives
- filtration information
- coolers
- shipping details
- starting date
- expected duration

v) Arrange access to the site. Assemble well keys and site keys. Also consider site conditions.

vi) Plan sampling sequence to ensure that "clean" wells are sampled before "dirty" wells to reduce cross-contamination potential.

vii) Plan the sampling sequence to ensure that wells that purge dry fit into the overall sampling schedule to reduce the need for extension of the sampling period and to reduce the need for weekend purging/sampling.

Note: Pre-plan the schedule of sampling activities such that sample collection progresses from "clean" to "dirty" areas in an effort to eliminate the potential for cross-contamination. Review previous analytical data (if available) to determine the best sampling sequence.

PROCEDURAL PRECAUTIONS

Consider the following precautions when collecting groundwater samples:

- Special care must be taken not to contaminate samples. This includes storing samples in a secure location to preclude conditions that could alter the properties of the sample. Samples should be custody sealed during long-term storage or shipment.
- Always sample from the anticipated cleanest, i.e., least contaminated location, to the most contaminated location. This minimizes the opportunity for cross-contamination to occur during sample collection.
- Collected samples must remain in the custody of the sampler or sample custodian until the samples are relinquished to another party.
- If samples are transported by the sampler, they should remain under his/her custody or be secured until they are relinquished.
- Shipped samples should conform to all U.S. Department of Transportation (DOT) rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179), and/or International Air Transportation Association (IATA) hazardous materials shipping requirements found in the current edition of IATA's Dangerous Goods Regulations.
- Field sampling activities should be documented in a bound logbook.
- Chain-of-custody documents should be filled out and remain with the samples until custody is relinquished.
- All shipping documents, such as air bills, bills of lading, etc., should be retained by the project leader and placed in the project files.

EQUIPMENT NEEDS

The following is a general list of equipment, which will be required to complete the tasks associated with this SOP. Additional equipment may or may not be required for any specific task.

- equipment decontamination supplies (SOP 2)
- field logbook and water sampling data forms

- task specific documents and maps
- sample/purge pumps
- water level meter
- portable electric power supply or compressed air source
- PTFE and polyethylene tubing and stainless steel fittings
- air monitoring equipment
- PPE as specified in the HASP
- cooler and ice
- sample containers (sample container and preservative requirements are provided in Table 3 of the FSP and Worksheet #19 of the QAPP)
- 5-gallon buckets and or portable tanks
- water quality meters (pH, conductivity, temperature, redox, DO, and turbidity)
- camera
- re-sealable baggies

FIELD PROCEDURES

Well Identification/Inspection

Once at the well location and prior to sample collection activities, confirm that the well to be sampled has been correctly identified and located. Be alert to potential cap switching, mislabeled locations, or unlabeled well sites.

Determine proper well locations by checking well identification tags (if present) and comparing well log details to measured well details (i.e., total well depth, casing diameter, casing stick-up or stick-down distances), field ties, and site plans.

Once the correct monitoring well is identified, thoroughly inspect the well to determine if the well is suitable for sampling. Determine if the cap and lock are secure or if there is evidence of tampering. If the well is unlocked, replace the lock. Note any cracks in the protective casing or surface seal, as well as any subsidence in the vicinity of the well. Record inspection details in the sampling field logbook and/or Well Inspection Form.

Note the results of the well inspection (even if the well is in perfect condition) and inform the FWS representative of any required repairs. Arrange to have any unmarked wells permanently marked for proper identification. (Place a temporary marking at the time of sampling.) If well identification tags or markings appear to be fading, arrange to have the tags or marking replaced. **Verify that at least 3-days have passed between development and sampling**.

Air Monitoring

Prior to opening the well cap, measure the breathing zone above the well casing with a photoionization detector (PID) to establish baseline levels. Repeat this measurement once the well cap is opened. If either of these measurements exceed any of the air quality criteria established in the health and safety plan, then the appropriate respiratory protection must be worn.

Water Level Monitoring/Well Depth Sounding

Prior to commencing the groundwater purging/sampling tasks, obtain a water level to determine the well volume and for hydraulic purposes. Refer to SOP 6 for procedures to be followed.

GROUNDWATER SAMPLING

Monitoring Wells

Collect samples progressively from the least suspected contaminated area to the most suspected contaminated area. Follow the procedure below to collect groundwater samples from monitoring.

i) Don a new pair of disposable nitrile gloves (or equivalent) at each location immediately prior to sampling. Ensure that all sampling equipment has been properly decontaminated pursuant to SOP 2 and that all instruments have been properly calibrated (calibration results should be logged in a field logbook).

ii) Place an unused section of clean plastic sheeting around the well that is large enough to allow all sampling and related equipment to be placed on the plastic and to prevent groundwater from reaching the surrounding soils.

iii) Measure the depth to water in each well to the nearest 0.01 foot using a pre-cleaned electronic water level meter (see SOP 6). Measure the depth to water from the fixed reference point (notch) on the north side of the well casing. Obtain the well depth from the well log. **Measure well depth after sampling is completed, to minimize re-suspension of settled solids**.

iv) Use a pre-cleaned stainless steel bladder pump with a PTFE bladder, stainless steel electric submersible pump (Grundfos® or similar) for purging. (All sampling devices should be constructed of stainless steel, glass, PTFE, or other inert materials to minimize the chance of the materials altering the groundwater.) Fit the pump with sufficient length (well depth plus an additional 5 to 10 feet) of clean PTFE or polyethylene tubing dedicated to the well. Use PTFE tubing at permanent monitoring well locations being sampled for VOCs; if the monitoring well is not being sampled for VOCs, then use polyethylene tubing. **Lower the pump and tubing very slowly into position to minimize mixing of the stagnant well casing water and to minimize the agitation of any solids into suspension, which will increase purging time.** Position the pump or tubing in the well such

that the intake corresponds to the approximate middle of the well screen (portion of screen under water). Review the well log to determine the approximate middle of the well screen. If possible, maintain a minimum of 2 feet between the pump intake and the well bottom or sediment level, if present.

v) Purge the monitoring well at a pumping rate between 100 and 500 milliliters per minute (mL/min). Start the pumping at a very low flow rate and increase the rate slowly to minimize the agitation of solids. For wells with slow recovery, avoid purging them to dryness. Schedule the sampling of wells that have a slow recovery so that they can be purged and sampled in the same day, after adequate volume has recovered. Do not purge wells of this type at the end of one day and sample the following day.

vi) Measure the groundwater level with an electronic water level meter while purging with a goal of less than 0.3 feet of drawdown if possible. Adjust the flow within the specified range as necessary.

vii) Measure water field parameters approximately every 3 to 5 minutes using a flow-through cell and a turbidity meter. If purge water initially appears turbid, continue purging until the purge water becomes visibly less turbid before connecting the flow-through cell.

viii) Continue purging until field parameters have stabilized. When three successive readings of the water-quality-indicators have stabilized within the following limits, sampling may begin:

pH	±0.1 pH units
temperature	±0.5 degrees Celsius or ±1 degree Fahrenheit
conductivity	±3 percent;
dissolved oxygen	±0.3 mg/L
turbidity	a final value of less than 10 nephelometric turbidity units (NTUs)

ix) Disconnect the tubing from flow-through cell and collect groundwater through the tubing directly into laboratory supplied containers in order of decreasing analyte volatility using techniques that minimize sample agitation. During sample collection, ensure that the pump discharge line or the bailer does not contact the sample container.

Collect and containerize samples in the order of the following volatilization sensitivity:

i) volatile organic compounds

ii) semivolatile organic compounds

iii) pesticides

Label groundwater samples immediately and place into a cooler containing ice as described in SOP 9.

x) In the event that the groundwater recharge to the monitoring well is insufficient and the well will be pumped to dryness or the field parameters fail to stabilize following the removal of five well volumes, allow groundwater to recover to a level sufficient for sample collection. Upon recovery, collect groundwater samples as described above. Alternately, if a well is purged dry prior to stabilization, after allowing the well to recover, use a new disposable PTFE bailer and a new section of braided nylon rope to collect the groundwater sample.

xi) **Measure well depth after sampling is complete to minimize re-suspension of settled solids**.

FIELD NOTES AND DOCUMENTATION

Document all the events, equipment used, and measurements collected during the sampling activities in the field notes. Ensure that the field notes are legible and concise such that the entire sample event can be reconstructed for future reference.

Record field notes in a field logbook issued for general note taking/field records and/or field data sheets.

Document the following for each well sampled:

- name of collector(s)
- identification of well
- depth to water
- static water level depth and measurement technique
- well depth (measured after sampling)
- presence of immiscible layers and detection/collection method
- well yield - high or low
- purge volume and pumping rate
- time well purged
- measured field parameters
- purge/sampling device used
- sample appearance

- sample odors (if respiratory protection is not required)
- sample identification numbers
- depth of sample collection
- collection of QA/QC samples
- decontamination procedure
- preservative(s) used
- parameters requested for analysis
- field analysis data and method(s)
- sample distribution and transporter
- laboratory shipped to
- chain-of-custody number for shipment to laboratory
- field observations on sampling event
- climatic conditions including air temperature, precipitation, etc.
- problems encountered and any deviations made from the established sampling protocol

FOLLOWUP ACTIVITIES

Perform the following once field activities are complete:

i) Double check Work Plan to ensure all samples have been collected.
ii) Decontaminate equipment (SOP 2) and return to the equipment administrator.
iii) Complete purge water disposal, and cleaning fluid disposal requirements per the SOP 11.
iv) Notify the contract laboratory as to when to expect the samples. Enclose the chain-of-custody and covering letter, indicating the parameters and number of samples, in the sample cooler.
v) Complete the logbook.
vi) Return site/well keys.

It is not sufficient to write in the logbook "sample collection and decontamination was done in accordance with the project SOPs." Rather, the logbook should detail the steps and materials used for all the requirements as noted above.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 8
SINGLE-WELL RESPONSE TESTS
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

The slug test involves inducing a sudden change in water level in a well and measuring the water level response within that well over time. Water level change may be induced by suddenly injecting or removing a known quantity or "slug" of water into or out of the well, emplacement or removal of a solid slug (i.e., stainless steel, PVC) into the water column, or a release of pressure in a tightly capped well.

GENERAL

Perform single-well hydraulic response testing (slug tests) on newly installed monitoring wells identified in the Work Plan to estimate the hydraulic conductivity of the overburden stratigraphic unit.

Prior to beginning fieldwork, identify and provide the U.S. Fish and Wildlife Service the qualifications for personnel who will be conducting the slug tests. Education or training related to groundwater hydrogeology and experience with specific testing equipment will be considered part of the qualifications.

Document all deviations from the procedures required by this SOP in a standard bound field logbook (logbook). In addition, implement corrective action as described in Worksheets #6, #14, #31-1, and #32-1 of the Quality Assurance Project Plan (QAPP). If corrective action is not required, describe the basis for that determination in the logbook.

PRIOR PLANNING AND PREPARATION

Prior to going into the field to perform the single well response test, perform the following tasks:

i) Review the Work Plan, Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.

ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed.

iii) Assemble site plan and well logs that will be required for the planned testing event. Determine the exact number and locations of the wells to be tested.

iv) Arrange access to the site. Assemble well keys and site keys. Also consider site conditions.

v) Plan testing sequence to ensure that "clean" wells are tested before "dirty" wells to reduce cross-contamination potential.

EQUIPMENT NEEDS

The following is a general list of equipment, which will likely be needed to complete the tasks associated with this SOP. This is a general list of equipment; additional equipment may or may not be required for any specific task.

- equipment decontamination supplies as specified in SOP 2
- field logbook, field forms (hard copy or electronic)
- task specific documents and maps
- purge pump/bailer
- water level meter
- portable computer
- polyethylene tubing and stainless steel fittings
- air monitoring equipment
- PPE as specified in the HASP
- pressure transducer and data logger
- 5-gallon buckets and or portable tanks
- camera

PROCEDURE

Conduct in-situ testing to estimate hydraulic conductivity following well installation. At the completion of the test, decontaminate the non-dedicated equipment per SOP 2.

In general, perform hydraulic response tests by pumping water from the well as described in part A of this section. However, under some conditions (i.e., very permeable formations), the slug test can best be conducted by simulating the withdrawal/injection of a slug of water by the release of pressure in a tightly capped well as described in part B.

A. Water Purging

Site-specific procedures for removing a slug of water for response testing are as follows:

i) Decontaminate testing equipment prior to each response test. Use the same procedure outlined for water level meters in SOP 2.

ii) Gauge the static water level in the well using an electronic water level indicator (see SOP 6) and record the level in the logbook.

iii) Lower a 10 pound per square inch (PSI) pressure transducer attached to an electronic data logger into the well.

iv) Fully submerge a pre-cleaned electric submersible pump, or tubing attached to a peristaltic pump, or disposable bailer into the monitoring well and allow the water level to equilibrate to its original level. Record water level measurements demonstrating that the water level has equilibrated along with the time of measurement in the logbook.

v) Operate the pump, or remove the bailer to lower the water level in the well.

vi) Allow the data logger to monitor and record the water level recovery into the well.

The pressure transducer with data logger measures and records hydraulic head changes to determine the water levels. The rate of recovery is a function of the hydraulic conductivity of the formation. Download the water level recovery data recorded by the data logger into a personal computer, and evaluate the data using the methods developed by Bouwer and Rice using AQTESOLV™ software by HydroSolve, Inc.

B. Slug Simulation

The procedure for slug removal simulation is as follows:

i) Insert the pressure transducer at a sufficient depth below the water table. Check the operation of the transducer and data recorder.

ii) Install sealed well cap with a pressure cap.

iii) Increase the pressure in the well to lower the water level (usually a bicycle pump is a sufficient source of compressed air).

iv) Release the pressure by opening a valve on the well cap and allow well to recover.

vii) Allow the data logger to monitor and record the water level recovery into the well.

Download the water level recovery data recorded by the data logger into a personal computer, and evaluate the data using the methods developed by Bouwer and Rice using AQTESOLV™ software by HydroSolve, Inc.

RECORDED INFORMATION

Document response-testing activities in the field logbook and include the following:

- site location, date, time, and weather
- inside diameter of the well screen and well casing
- borehole diameter
- depth of well

- static water level
- length and depth setting of the screen

It is not sufficient to write in the logbook "decontamination was done in accordance with the SOP." Rather, the field logbook should detail the steps and materials used for decontamination, the equipment that was decontaminated, and all the requirements as noted above.

FOLLOWUP ACTIVITIES

Complete the following at the conclusion of field activities for the day:

i) Double check Work Plan to ensure all locations have been tested.

ii) Clean and return the equipment to the equipment administrator.

iii) Complete purge water disposal and cleaning fluid disposal requirements per SOP 11.

iv) Complete and file the appropriate forms and data files.

v) Return site/well keys.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 9
SAMPLE MANAGEMENT AND FIELD QA/QC
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Sample management is the continuous care given to each sample from the point of collection to receipt at the analytical laboratory. Good sample management ensures that samples are properly recorded, properly labeled, not lost, broken, or exposed to conditions, which may affect the sample's integrity. All sample submissions must be accompanied with a chain-of-custody (COC) document to record sample collection and to maintain the integrity of the samples by providing documentation of the control, transfer, and analysis of samples. This is especially important in environmental work where sampling can identify the existence of contamination.

GENERAL

Document all deviations from the procedures required by this SOP in a standard bound field logbook (logbook). In addition, implement corrective action as described in Worksheets #6, #14, #31-1, and #32-1 of the Quality Assurance Project Plan (QAPP). If corrective action is not required, describe the basis for that determination in the logbook.

PRIOR PLANNING AND PREPARATION

The following shall be considered prior to performing sampling activities:

i) Review the Work Plan, Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.
ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and decontaminate and calibrate as needed.
iii) Assemble site plan, well logs, and previous sampling data that will be required for the planned sample event. Determine the exact number and locations to be sampled and the types of media samples to be collected.
iv) Contact the project chemist to arrange:
    - laboratory
    - glassware
    - preservatives
    - filtration information
    - coolers
    - shipping details
v) Arrange access to the sampling site. Assemble well keys and site keys as required. Also consider site conditions.

FIELD HANDLING

Prior to entering the field area where sampling is to be conducted, especially if the site has defined exclusion zones, the sampler should ensure that all materials necessary to complete the sampling are on hand.

If samples must be maintained at a specified temperature after collection, proper coolers and ice/cool-packs must be brought out to the field regardless of the ambient temperature.

Consideration should be given to keeping reserve cooling media on hand if sampling events will be of long duration. Conversely, when sampling in extremely cold weather, proper protection of water samples, trip blanks, and field blanks must be considered.

Personnel performing sampling tasks must check the sample preparation and preservation requirements to ensure compliance with the project QAPP. Typical sample preparation may involve pH adjustment (i.e., preservation), sample filtration and preservation, or simply cooling to 4°C. Sample preparation requirements vary from site to site and vary depending upon the analytical method for which the samples will be analyzed.

SAMPLE LABELING

The sample identification format for this investigation has been designed to uniquely identify each sample from each sampling program and event.

An example of the sample identification format is described below:

AUS-PEST-00A-SD-000005: The first two parts of the number identifies the AUS OU pesticide site, Area 7.

AUS-PEST-00A-SD-000005: The third part of the number identifies the sample location within that site;

AUS-PEST-00A-SD-000005: The fourth part of the number identifies the media (SS=soil, SD=sediment; GW=groundwater; SW=surface water; WI=wipe samples; BI=biota[fish tissue]). The fourth part also identifies a QC sample where appropriate (EB=equipment rinsate blank; AB=ambient blank; TB=trip blank);

AUS-PEST-00A-SD-000005: If applicable, the fifth position will be a 6-digit number describing the sample interval depth, in feet. The first three digits indicate the top depth of the sample interval, and the last three digits indicate the bottom of the sample interval (each to the nearest 0.1 feet). For example:

- 000005 is a sample collected from the 0 to 0.5′ bgs interval
- 005020 is a sample collected from the 0.5′ to 2′ bgs interval
- 020025 is a sample collected from the 2′ to 2.5′ bgs interval
- 050100 is a sample collected from the 5′ to 10′ bgs interval

Fishes collected for chemical analysis and necropsy will be identified by species. A three-letter species designation will be affixed to the end of the sample designation as an additional descriptor. The species designations are as follows:

- "LMB" = Largemouth Bass
- "SMB" = Smallmouth Bass
- "STB" = Striped Bass
- "WHB" = White Bass
- "YLB" = Yellow Bass
- "CAT" = Catfish
- "BLU" = Bluegill
- "SHA" = Gizzard Shad

- "CAR" = Common Carp
- "MIN" = Common Minnow

Wipe samples collected from the Warehouse buildings will identify the building, and the location within the building (e.g. wall, floor, or frame) where the sample was collected. The building ID and a three digit code for the sample location will be affixed to the end of the sample designation as an additional descriptor. For example:

- "AUS-PEST-001-WI-IN13-WAL" is a sample collected from the building IN-1-3 wall at location #1.
- "AUS-PEST-002-WI-IN13-FLR" is a sample collected from the floor of building IN-1-3 at location #2.
- "AUS-PEST-003-WI-IN13-FRM" is a sample collected from the frame of building IN-1-3 at location #3.

For samples of waste material and samples collected from tanks or roll-off boxes, replace the fourth and fifth positions by a four-digit descriptor such as "Tank" for a wastewater sample. Number duplicate samples in the fifth position sequentially for soil and groundwater starting with 600000, and for sediment and surface water starting with 400000. This will ensure that duplicate samples cannot be distinguished from the original sample at the laboratory. Note the details of the original sample for which it is a duplicate in the field logbook.

Include a unique sample identification number, the sampler's initials, if the sample is grab or composite, the place of collection, the date and time of collection, and the analyses to be performed on the sample label. Apply completed labels to sample containers immediately after collection and prior to placing inside the cooler.

Write sample information on the labels using waterproof, non-erasable ink. Secure the adhesive labels to the bottle. Use waterproof write-in-the-rain labels. If such labels are not available, secure the labels to the sample container using wide clear tape over the label and wrap completely around the container before packing in a cooler. Ensure that the clear tape is not placed across the cap of the sample container. Do not use clear tape on samples collected for VOC analysis.

PACKAGING

Complete sample container preparation and packing for shipment in a well-organized and clean area that is free of any potential cross-contaminants. Wipe containers clean of all debris/water using paper towels (dispose paper towels with other potentially contaminated materials).

While there is no one "best" way to pack samples for shipment, follow these general packing guidelines:

i) Plan time to pack your samples (and make delivery to shipper if applicable). Proper packing and manifesting takes time. (A day's worth of sampling can be easily wasted due to a few minutes of neglect when packing the samples).

ii) Always opt for more coolers and more padding rather than crowding the samples. The cost and lost time associated with the packing and shipment of additional coolers is usually always small in comparison with re-sampling due to breakage during shipment.
iii) Do not bulk pack. Individually pad each sample.
iv) Use more space and padding between large glass containers (1 liter and up).
v) Do not use ice as a packing material due to its reduction in volume when it melts.

Follow these standard guidelines when packing samples for shipment:

i) Remember that the laboratory to which the samples will be shipped depends on the analysis to be performed. Consult Table 3 of the FSP and Worksheet #19 of the QAPP to determine the appropriate analytical laboratory and plan accordingly during sample packaging.
ii) Line the inside of the cooler with a plastic liner or bubble wrap.
iii) When using ice for a cooling media, always double bag the ice in "Zip-Lock" bags to minimize the potential for leakage.
iv) Use bubble wrap to cushion individual sample containers.
v) Double-check to ensure temperature blanks have been included for all shipments and trip blanks are included in coolers containing VOCs, or where otherwise specified in the QA/QC plan. Include a trip blank with each shipment of multiple groundwater and/or surface water samples submitted for analysis of VOCs.
vi) Prior to sealing the cooler, double check the samples in the cooler with the samples listed on the corresponding Chain-of-Custody form.
vii) Enclose the completed and signed Chain-of-Custody form in a "Zip-Lock" bag. Tape the Zip-Lock bag to the inside of the cooler lid. Each cooler shipped should contain at least one Chain-of-Custody form that identifies the samples contained in that cooler.
ix) Place custody seals on each cooler. The seal must be signed and dated by the field investigator. Place the custody seal on the container so that it cannot be opened without breaking the seals. Place the seal on the opening edge on coolers with hinged lids. Place seals on opposite diagonal corners of the lid on coolers with "free" lids. The seal should secure the lid and provide evidence that the samples have not been tampered with en-route to the project laboratory. Secure the cooler with nylon strapping tape. Mark shipping coolers with “THIS END UP,” and affix arrow labels to indicate the proper upward position of the container. Place clear tape over the chain-of-custody seals to ensure that they are not accidentally broken during shipment.
x) Ensure that all "Hazardous Material" stickers/markings or previous shipping labels have been removed from coolers which previously contained such materials. Comply with DOT regulations for shipping.

Note: Never store clean sample containers in enclosures containing equipment using any form of fuel or volatile petroleum based product. An alternate means of secure storage must be planned for.

When conducting sampling in freezing conditions without a heated storage area (free of potential cross contaminants), isolate trip blanks and temperature blanks not being used in a QA/QC role from coolers immediately after receipt. Double-bag trip and temperature blanks and keep from freezing.

CHAIN-OF-CUSTODY RECORDS

Include a chain-of-custody form with each sample cooler being shipped to the laboratory. Attachment 1 to this SOP includes copies of the ECCS and ALS Chain-of-Custody (COC) Form. Distribute copies of the chain-of-custody form as follows: maintain one copy as the shipper and enclose the remaining copies (two copies for ECCS, and one copy for ALS) in a waterproof envelope within the cooler with the samples. Seal the cooler properly for shipment. The laboratory, upon receiving the samples, will complete the remaining copies. The laboratory will scan the completed COC form for inclusion in their Laboratory Information Management System (LIMS), and return the executed original with the data deliverables package. Copies of the COC and the laboratory electronic data deliverable (EDD) will be provided to the Respondent.

Complete the chain-of-custody record at the time of sampling. The record should contain, but not be limited to, the sample number, date and time of sampling, required analyses, and the name of the sampler. The chain-of-custody document should be signed and dated by the sampler when transferring the samples.

Complete and handle all COC forms using the following guidelines.

i) Use standard COC forms supplied by the project analytical laboratory. (No COCs forms from other labs will be used, even if the heading is blocked out)
ii) Complete COC forms in black ball-point ink only.
iii) Complete COC forms neatly using printed text.
iv) If a simple mistake is made, line out the error with a single line and write initials and date next to it.
v) Number each separate sample entry sequentially.
vi) Avoid the use of "Ditto" or quotation marks to indicate repetitive information in columnar entries. If numerous repetitive entries must be made in the same column, place a continuous vertical arrow between the first entry and the next different entry.
vii) When more than one COC form is used for a single shipment, consecutively number each form using the "Page ___ of ___" format.
viii) If necessary, place additional instructions directly onto the COC form. Do not enclose separate loose instructions.
ix) Include a contact name and phone number on the COC form in case there is a problem with the shipment.
x) Maintain a copy of the COC form in the field file.
xi) Do not indicate the source of the sample as this may produce a biased lab result.
xii) Before using an acronym on a COC form, define clearly the full interpretation of your designation [e.g., Polychlorinated Biphenyls - (PCBs)].

SHIPMENT

In all but a few cases, the QA/QC plan for the field work will require shipment of samples by overnight courier. Many problems can be avoided by proper advance planning.

Prior to the start of the field sampling, contact the carrier to determine if pickup can be made at the field site location. If pickup at the field site can be made, determine the "no-later-than" time for having the shipment ready.

If no pickup is available at the site, determine the nearest manned pickup or drop-off location. Again, determine the "no-later-than" time for each location. Do not leave sample shipments at unmanned, unsecured or at questionable drop locations (i.e., if the cooler will not fit in a remote drop box do not leave the cooler unattended next to the drop box).

Some overnight carriers do not in fact provide "overnight" shipment to/from some locations. Do not assume; call the carrier in advance before the start of the field work.

Maintain copies of all shipment manifests in the field file.

Review analytical hold times prior to collecting samples on Saturday, Sunday or holidays. Ship samples collected on a Saturday or the day before a holiday with additional ice in the coolers. Place samples collected late on a Saturday, Sunday or on a holiday in coolers with extra ice. Seal and store the coolers in a secure location following chain of custody procedures[1], and shipped by the courier on the next business day.

FIELD QUALITY CONTROL/QUALITY ASSURANCE (QA/QC)

To ensure the validity of data from the sampling and analysis program, collect and submit field Quality Control (QC) samples for analysis. Field QC samples consist of field duplicate samples, field equipment rinsate blank samples, trip blank samples, matrix spike/matrix spike duplicate (MS/MSD). Collect field duplicate samples during each monitoring event at the frequencies specified in the QAPP.

Equipment Rinsate Blanks

Equipment rinsate blanks are defined as QA/QC samples used to determine if cleaning procedures are effective and adequate. To prepare equipment rinsate blanks, collect laboratory-grade organic free water that has been "run through" or "poured over" the cleaned sample collection equipment. Submit the equipment rinsate samples to the lab "blind." Equipment blanks are typically collected at the sample collection area of the project site.

[1] Lock sample coolers in a secure place when out of physical sight of the sampling or delivery personnel (e.g., put the sample coolers in locked rooms or locked automobile trunks), or they may be invalidated in a court of law. If the samples are left in a secured area, record the date, time, and location of the secured area on the COC form.

Complete preservation or filtration (if required) on the respective blank aliquots to ensure that each step of the sampling procedure is evaluated.

Do not collect rinsate blank samples for dedicated or disposable soil or groundwater sampling equipment. Field rinsate blank sample data provide information regarding the efficacy of the equipment decontamination procedures.

Trip Blanks

Trip blank samples will be prepared by the laboratory, shipped with the sample containers, and returned unopened to the laboratory with multiple aqueous samples for VOC analysis. Trip blank sample data provide information on sample cross-contamination by VOCs during sample shipping and storage. Do not open the trip blank samples. They are intended to determine if the sample shipping or storage procedures influence the analytical results.

Field Duplicates

Collect and submit field duplicates to assess the potential for laboratory data inconsistency and the adequacy of the sampling and handling procedures. Collect a duplicate sample from the same source utilizing identical collection procedures.

During groundwater sample aliquot collection, collect the original and duplicate sample simultaneously by partially filling the original and then the duplicate and alternating back and forth until both samples have been fully collected. This will provide two representative samples for analyses. Transferring the sample aliquot from a bulk container to the respective sample containers is typically not permissible.

Submit the field duplicates to the laboratory "blind" by providing a false identification number. Submit the sampling key to the appropriate personnel to ensure proper sample identification and to enable completion of the QA/QC review process.

Matrix Spike/Matrix Spike Duplicate

Collect MS/MSD groundwater samples from a well representative of the condition of the majority of the monitoring wells. Identify the samples collected for MS/MSD analysis on the chain-of-custody forms sent to the project laboratory. Provide additional sample volume as necessary to the laboratory for matrix spike/matrix spike duplicate (MS/MSD) analysis. MS/MSD samples are investigative samples that are analyzed by the laboratory to evaluate analytical accuracy and precision relative to the sample matrices.

MS/MSD sample volumes are additional sample aliquots (additional for aqueous samples only) provided to the laboratory to evaluate the accuracy and precision of the sample preparation and analysis technique. Sample labeling identifies the respective sample location and each additional container that is labeled as the "MS/MSD" volume.

Environmental Chemistry Consulting Services, Inc.
2525 Advance Road
Madison, WI 53718
608-221-8700 (phone)
608-221-4889 (fax)

CHAIN OF CUSTODY

Lab Work Order #:

Project Number:	Mail Report To:
Project Name:	Company:
Project Location:	Address:
Turn Around (check one): ☐ Normal ☐ 5 BDs ☐ 3 BDs ☐ 2 BDs ☐ 24 hrs	E-mail Address:
If Rush, Report Due Date:	Invoice To:
Sampled By (Print):	Company:
	Address:

Preservation Codes

Analyses Requested

Sample Description	Collection Date	Collection Time	Matrix	Total # of Containers							Comments	Lab ID	Lab Receipt Time
					☐	☐	☐	☐	☐	☐			
					☐	☐	☐	☐	☐	☐			
					☐	☐	☐	☐	☐	☐			
					☐	☐	☐	☐	☐	☐			
					☐	☐	☐	☐	☐	☐			
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Preservation Codes
A=None B=HCL C=H_2SO_4
D=HNO_3 E=EnCore F=Methanol
G=NaOH O=Other (Indicate)

70/144

Matrix Codes
A=Air S=Soil W=Water O=Other

Rush TAT Multipliers
5 Business Days = 1.5x
3 Business Days = 2x
2 Business Days = 2.25x
24 Hours = 2.5x
must be pre-arranged

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:

Custody Seal: ☐ Present ☐ Absent ☐ Intact ☐ Not Intact Seal #s: | Shipped Via: | Receipt Temp: | Temp Blank: ☐ Y ☐ N

CHAIN OF CUSTODY

ALS Environmental

1317 South 13th Ave., Kelso, WA 98626 | 360.577.7222 | 800.695.7222 | 360.636.1068 (fax)

SR# _____

PAGE _____ OF _____ COC# _____

PROJECT NAME

PROJECT NUMBER

PROJECT MANAGER

COMPANY NAME

ADDRESS

CITY/STATE/ZIP

E-MAIL ADDRESS

PHONE # FAX #

SAMPLER'S SIGNATURE

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS	Semivolatile Organics by GC/MS 625☐ 8270☐ 8270LL☐ SIM PAH☐	Volatile Organics 524☐ 8260☐ 8021☐ BTEX☐	Hydrocarbons (*see below) Gas☐ Diesel☐ Oil☐ Oil & Grease/TRPH 1664 SGT☐ 1664 HEM☐	PCBs Aroclors☐ Congeners☐	Pesticides/Herbicides 608☐ 8081☐ 8141☐ 8151☐	Chlorophenolics - 8151M Tri☐ Tetra☐ PCP☐	Metals, Total or Dissolved (See List below)	Cyanide☐ Hex-Chrom☐	(circle) pH, Cond., Cl, SO_4, PO_4, F, NO_2, NO_3, BOD, TSS, TDS, Turb.	(circle) NH_3-N, COD, TKN, TOC, DOC, NO_2+NO_3, T-Phos	TOX 9020☐ AOX 1650☐ 506☐	Alkalinity ☐ CO_3 ☐ HCO_3 ☐	Dioxins/Furans 1613☐ 8290☐	Dissolved Gases CO_2☐ RSK 175☐ Methane☐ Ethane☐ Ethene☐				REMARKS

REPORT REQUIREMENTS

___ I. Routine Report: Method Blank, Surrogate, as required

___ II. Report Dup., MS, MSD as required

___ III. CLP Like Summary (no raw data)

___ IV. Data Validation Report

___ V. EDD

INVOICE INFORMATION

P.O. # _____

Bill To: _____

TURNAROUND REQUIREMENTS

_____ 24 hr. _____ 48 hr.

_____ 5 day

_____ Standard (15 working days)

_____ Provide FAX Results

_____

Requested Report Date

Circle which metals are to be analyzed:

Total Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

***INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORTHWEST OTHER: _____ (CIRCLE ONE)**

SPECIAL INSTRUCTIONS/COMMENTS:

☐ Sample Shipment contains USDA regulated soil samples (check box if applicable)

RELINQUISHED BY:		RECEIVED BY:		RELINQUISHED BY:		RECEIVED BY:	
Signature	Date/Time	Signature	Date/Time	Signature	Date/Time	Signature	Date/Time
Printed Name	Firm	Printed Name	Firm	Printed Name	Firm	Printed Name	Firm

711444

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 10
FISH SAMPLING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

PURPOSE

The purpose of this SOP is to describe general methodologies for collecting fish specimens from surface water bodies, documenting and processing the specimens. External and internal examination for sex determination and morphological abnormalities, necropsy, and tissue collection for aging, histopathology and chemical analysis will either be performed in the field or at an off-site laboratory. Age, histopathology and chemical analysis will be performed at off-site laboratories. Since lipid content in fish tissue can be low in the spring, spring sampling should be avoided (USEPA 2008[1]). Sampling should not be done 2-4 weeks before or after the spawning season and should be conducted during the legal fishing season.

This SOP should only be implemented in conjunction with an appropriate Health and Safety Plan.

SCOPE

This Work Instruction applies to all contractors and subcontractors with responsibility for collection of fish specimens, and for preserving and submitting them for laboratory analysis.

DEFINITIONS

- Boat-mounted electrofishing unit: An electrofishing unit consisting of dual aluminum booms extending approximately 5 feet off the bow of a boat. Electrical cables connect the booms to a commercial electrical fish shocking unit (Smith-Root 1.5 KVA Electrofisher or equivalent) that produces an electrical field varying from 175 volts at 1 amp to 400 volts at 6 amps. A portable gas generator powers the unit.
- Stream electrofishing shocker: Electrofishing equipment that uses a small (two- to three-meter) pram to float a gasoline-powered generator and associated electrical connections.
- Backpack electrofishing shocker: Electrofishing equipment consisting of a self-contained electronic control unit coupled to and powered by either a DC battery or small gasoline-powered generator that is mounted on a pack frame worn by a crewmember.
- Block net: A small-mesh net that is used to block off upper and lower ends of stream sampling stations to restrict movement of fish into or out of the station.
- Gill net: A net with varying sizes of mesh openings that is set as a vertical wall in the water column to entangle fish attempting to swim through. This is also called an entangling net.
- Seine: A small-mesh net of varying lengths that is manually dragged or pushed through the water column toward shore.
- Dip net: A small-mesh (e.g., ¼-inch) hooped net on the end of a long handle that is used to scoop up stunned or trapped fish.

[1] USEPA. 2008. Sediment Assessment and Monitoring Sheet (SAMS) #1: Using Fish Tissue Data to Monitor Remedy Effectiveness. USEPA Office of Superfund Remediation and Technology Innovation and Office of Research and Development. OSWER Directive 9200.1-77D. July.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 10
FISH SAMPLING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

SAMPLING EQUIPMENT NEEDS

Equipment that may be required (additional equipment may be needed) to collect fish specimens includes the following:

- boat (may itself be equipped with electrofishing components for sampling large lakes and rivers)
- stream electrofishing shocker
  - aluminum pram
  - gasoline-powered generator
  - additional fuel in an approved container
  - hand-held electrode(s) with insulated handles
  - cathode array suspended from the transom of the pram
  - appropriate electrical connections (consult operating manuals or text for wiring diagrams that provide the desired type of electric field)
- backpack electrofishing shocker
  - commercial backpack unit with a fully charged battery or a small gasoline-powered generator
  - appropriate number and type of electrodes for one-, two-, or three-person operation
  - additional fuel in approved containers (if using gasoline-powered generator)
- rubberized waders for all personnel in the water
- depth finder or demarcated weighted line
- gill nets
- block nets
- dip nets
- seines
- tether lines, shore anchors, and buoys
- measuring board and tape (millimeter [mm])
- five-gallon buckets, live well, or wash tub
- resealable clean plastic bags (one-quart and one-gallon)
- heavy-duty aluminum foil
- preprinted adhesive sample labels
- collecting permit(s) (or other required permits)
- site map
- chain-of-custody (COC) forms

- permanent ink pens
- clipboard
- field identification guides
- field logbooks
- field data forms
- tool kit
- balance or scale
- measuring board
- field guides or keys

DISSECTION AND TISSUE COLLECTION EQUIPMENT NEEDS

- Sampling and Analysis Plan
- Fish health assessment field notebook
- Waterproof ink pens
- Camera and film
- Cellular phones
- First aid kit
- Fire extinguisher
- Fish Identification Manual
- Portable Canopy
- Tables & Stools
- Short-handled dip net (2) (for handling of all live fish, one per crew)
- 60 to 80 L cooler (2) (fish processing station live well)
- 20 to 40 L cooler (2) (icewater tank, one for each fish health sampling crew)
- Aerator (2)
- Airstones & tubing
- Water bucket (with liter marks on the inside)
- Meter measuring board with 1 mm divisions (2) (for measuring fish, one per fish health crew)
- Portable electronic balance and 500 g calibration standard (±20 g accuracy) (2) (for fish wet weight, one balance per fish health crew)
- Portable electronic balance and 10 g calibration standard (±0.01 g accuracy) (2) for tissue weights, one balance per fish health crew)
- Weigh paper and boats
- Scale knife (2) (for removing scales, one per fish health crew)
- Wire side cutters (2) (for removing dorsal fin spines, one per fish health crew)
- Polycarbonate cutting boards
- Dissecting scissors (1/fish, may be cleaned; for opening body cavity, cutting intestine and gill)

- Probe (1/fish, may be cleaned; for internal necropsy)
- Medium curved-tip forceps (1/fish, may be cleaned; for handling and manipulating
- Tissues)
- Sterile scalpel blade (1-#11, 1-#22 per fish, for tissue removal)
- Scalpel handles (2/fish, may be cleaned; one for each blade)
- Surgical steel razor blades (4/fish, for cutting tissues)
- Hemostat clamp (1/fish for scalpel blades)
- Paper towels
- Parafilm
- Flashlight/lanterns/headlamps.

DOCUMENTATION

The electroshocking collection crew will have a dedicated, bound field notebook in which all necessary information will be recorded. The general information that will be recorded includes page number, the location being sampled, location number as per work plan map, and time of the start and end of each fish collection activity, weather, habitat, sampling crew, and recorder's initials (including blank pages). Information specific to each collected fish will be recorded on shore and will include species and Floy tag number. The fate of each Floy tagged fish (used for sample collection, screened out from sample collection, died in holding, *etc*.) will be documented. All reviewed pages, including blanks, will be underlined and initialed.

A single member of each fish collection crew will be designated as a field recorder. Entries in the field notebooks will be made in waterproof ink, and any necessary corrections will be made with a single line through the error accompanied by the correction date and corrector's initials. Each field recorder will date, initial, and draw a line through any pages or entries not filled out. After the completion of each day's field activities, the notes will be reviewed for completeness and accuracy by the field recorder and the fish collection crew chief of each fish collection crew, and any necessary corrections will be made. Any corrections made to data sheets at the end of each day's collection activities will be explained in detail. Field notebooks will be scanned in each day to lessen loss of data in the event the field notebook is lost.

COLLECTION METHODS

The specific methods and gear used to collect fish specimens depend on the size, species and age of fish, the nature of the investigation, and characteristics of the sampling station (e.g., water depth, flow rate). Typical fish collection methods include traps, gill nets, electrofishing, seining, and hook and line (e.g., trotlines and angling). The following subsections describe general procedures and common collection methods.

A. Electrofishing Methods

Electrofishing can be used to collect adult and juvenile fish from shallow areas of lakes and rivers, and from shallow ponds and streams. Prior to use, all electrofishing equipment should be inspected to ensure the safe and proper operation of all components.

In waters too deep to wade, the primary fish collection device is a boat-mounted electrofishing unit. The electrofishing unit consists of dual aluminum booms extending approximately 5 feet off the bow of the boat. An umbrella array of stainless steel electrodes is attached to each boom and positioned so that it enters the water at a depth less than 2 feet. The array acts as the anode (+) and the boat hull serves as the cathode (-). The boom is connected with electrical cables to a commercial electrical fish shocking unit (Smith-Root 1.5 KVA Electrofisher or equivalent), which produces an electrical field varying from 175 volts at 1 amp to 400 volts at 6 amps. A portable gas generator powers the unit. Two to three people are needed to operate the boat-mounted electrofishing unit. One person operates the motor and steers the boat while the other person(s) operate(s) the electrofishing unit. Fish are immobilized by the electrical current and are retrieved and transferred to live wells containing a sufficient quantity of water from the sampling station.

In small wadeable streams, a backpack electrofishing shocker or stream electrofishing unit are secondary options. When sampling in a stream situation, each end of the sampling station should be blocked off as effectively as possible with block nets. The field crew should be in position prior to starting the generator, and should be aware of the locations of the electrodes and cathodes at all times. The generator should be started with safety switches in the "off" position. The switches should then be turned to the "on" position, and the unit should be inspected for proper operation.

For stream situations, sample collection should start at the downstream end of the sampling station. The operator should wade upstream, sweeping the electrodes back and forth across the area. Stunned fish should be scooped up with dip nets and transferred to live wells or collecting tubs containing a sufficient quantity of water from the sampling station. Fish should be processed immediately upon completion of each station. For fish not retained for sampling, the maximum hold time would be one hour. For a live well with continuous water exchange, or if the live well is in the embayment, fish to be retained as a potential sample may be held until the end of a given sampling day, provided that the fish are monitored and are not excessively stressed (e.g., by remaining continuously in hot sun). Fish that cease opercular movement after electrofishing will be disposed of without processing.

For each Fish Sampling Area, fish will be kept live until sufficient target species goals and/or the maximum sampling effort is achieved. At this time fish retained for necropsy and chemical analysis will be euthanized and shipped to the laboratory.

B. Passive Collection Methods

Certain species such as benthic dwelling species (catfish) require methods other than electrofishing. Passive methods of collection include gill nets, slat boxes, hoop and fyke nets, and trotlines. Gill nets are entangling methods of collection, and high mortality may result from these methods. Fish traps may also be used for fish sample collection. Fish traps can be constructed of netting material (hoop and fyke nets) or rigid material such as wood or metal (slat boxes and minnow traps). The selectivity of each method is dictated by the bait used, mesh size, and/or throat diameter of the trap.

SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 10
FISH SAMPLING
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

1. Traps

Typical traps include minnow traps, catfish traps, and fyke or hoop nets. Small or juvenile fish can be collected using minnow traps baited with canned cat food or poultry parts. A variety of bottom-feeding fish can be collected using baited catfish traps. Fyke and hoop nets can be used to collect any type of large mobile fish. Traps can either be placed directly on the bottom substrate, or can hang suspended above the bottom from floats. A single trap should be deployed in the general vicinity of each sampling station. Each trap should be secured to the shoreline with a tether, or weighted and the location marked by a buoy. Traps should be checked at least once every 12 to 24 hours.

2. Gill Nets

Gill nets can be used to collect a wide variety of adult and juvenile fish. A gill net set can include several mesh sizes (a stacked gill net), nominally ranging from 0.75 to 3.0 inches of stretched mesh, or the set can contain nets of a single mesh size.

Gill nets will be deployed for four hours at each sampling station and will be checked as soon as practicable at the end of the four-hour collecting period. The nets should be placed perpendicular to the shoreline, unless water depths exceed the effective depth of the nets. Each gill net should be anchored and buoyed at both ends unless deployed from the shoreline.

Since gill nets can be fatal to non-target aquatic and semi-aquatic species (such as turtles), each station should be evaluated to determine if the nets can be deployed without significant hazard to other wildlife. If gill nets cannot be deployed without substantial risk, alternative sampling methods should be used.

3. Seine

A seine is a flat, rectangular net held vertically in the water (usually with weights on the bottom and floats on the top) and pushed or dragged through the water toward shore. Seines can be used to collect adult and juvenile fish from virtually any body of water. Seines come in a variety of lengths, ranging from six feet to several hundred feet.

For larger bodies of water such as lakes and ponds, a long haul seine (or beach seine) can be used in conjunction with a boat, whereby one end of the seine remains on shore while the remainder is played out from the boat perpendicular to the shore. Once the entire length has been played out, the boat brings the end to shore some distance from the first end, and the seine is pulled in to shore manually. For smaller bodies of water such as streams, a short (e.g., 6- to 10-foot) seine with a wooden handle attached to each end can be pushed rapidly through the water, ending at an unobstructed shallow area of one of the banks. Fish should be processed immediately upon completion of each seine haul.

SAMPLE PROCESSING AND DOCUMENTATION

This section describes the procedures that will be used by the fish processing crews to conduct external and internal examinations and to collect tissues for chemical, histopathological, or other analyses. The general steps in the external examination, internal examination, and tissue collection procedures are shown in Figure SOP 10-1.

DOCUMENTATION

A project management notebook will track the capture location and holding time for each fish, the tally of fish numbers by sex and species, calibration notes for balances, shipping document numbers, general notes on sites and conditions, and procedural changes.

Individual Fish Data Sheets (including blank, formatted pages) will accompany each fish through the entire collection process. These data sheets will be collected into notebooks sorted by species and location.

Photographic documentation will be used to record the external and internal morphological examinations and necropsies. Abnormal morphological features and tissues designated by the pathologist will be photographed, as will several normal morphological features and tissues for photographic comparison to abnormal features. Photographic documentation will be conducted using a digital camera, and each photograph will be taken against a solid color background sheet with a sample identification label clearly visible in the photograph. The removable storage device will be changed daily and sequentially numbered (month, day, unique identification number). Removable storage devices will be archived as original data.

One member of each fish processing crew will be the designated recorder. Entries on the individual fish data sheets will be made in waterproof ink, and any necessary corrections will be made with a single line through the error accompanied by the correction date and corrector's initials. Each field recorder will date, initial, and draw a line through any pages and/or entries not filled out. After the completion of each day's field activities, the notes will be reviewed for completeness and accuracy by the field recorder and the crew chief, and any necessary corrections will be made. Any corrections made to data sheets at the end of each day's collection activities will be explained in detail. Individual fish data sheets will be photocopied weekly to lessen loss of data. Copies of relevant data sheets will be provided to laboratories for further analyses (histopathology and aging).

SAMPLE PROCESSING (Metrics, Morphology, Necropsy, Tissue Collection)

The catch from each trap, net, electrofishing event, or seine haul should be sorted immediately in the field for species identification and enumerated. For purposes of evaluating fish tissue samples associated with Area 7, bass and catfish fillet samples will be collected to support human health risk assessment. Bluegill and other forage fish (wholebody) will be collected to support ecological risk assessment. Based on the IEPA (1997)[2], it is recommended that fish of roughly

[2] IEPA. 1997. Quality Assurance and Field Methods Manual Section G: Procedures for Fish Sampling, Electrofishing Safety, and Fish Contaminant Monitoring.

similar size and weight be collected. For largemouth bass and channel catfish, individual fish should be two pounds or larger. For human health, the largest fish above the minimum size criteria in each sample (two pounds or larger and the legal limits) shall be analyzed for lipids and pesticides. The forage fish for ecological risk assessment shall be a minimum length of 4 inches. If fish of sufficient size cannot be captured to meet the size targets to support either the ecological or human health risk assessments, based on approval by the on-site FWS representative, either an alternative sample location will be selected or the fish most closely meeting the size criteria may be retained for analysis and the deviation documented in the field logbook and report. If smaller fish are collected, compositing may be necessary to obtain the minimum of 20 grams needed for laboratory analysis for pesticides. If compositing is necessary due to the need to collect smaller fish, prior to compositing FWS will be consulted. Note that no change should be made in the specific species targeted.

The following sample preparation procedures were derived from General Electric (2004)[3] for fish tissue collection on the Hudson River, USEPA (1998[4]2000[5] and 2011[6]), and Hudson River Natural Resource Trustees (2001)[7]. These procedures will be used to process fish selected for sampling, examination, and analysis.

LENGTH AND WEIGHT MEASUREMENT (STATION 1)

Procedure

1. Handle fish with a fresh pair of nitrile gloves. Remove a fish from the holding area and begin a Fish Data Sheet. A new data sheet is to be used for each fish that is processed. Record the species on the data sheet.

2. Rinse the fish with laboratory grade organic free water.

3. Attach an identification label that includes the fish sample identification number, Floy tag number fish length(s), weight(s), date and location sampled. The label should be easily visible in photographs of the fish. Record the unique fish sample identification number on the data sheet.

4. Record the species and any notable external abnormalities or features on the data form.

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[3] General Electric. 2004. Standard Operating Procedure Baseline Monitoring Program Revision No: 0 Standard Operating Procedures for Fish Sample Collection and Processing. February 27, 2004.
[4] USEPA, 1998. Standard Operating Procedures, Fish Handling and Processing. USEPA Environmental Response Team. SOP 2039
[5] USEPA. 2000. Guidance for Assessing chemical Contaminant Data for Use in Fish Advisories, Volume 1, Fish Sampling and Analysis, Third Edition. USEPA Office of Water. EPA 823-B-00-007.
[6] USEPA, 2011. Operating Procedure for Fish Field Sampling. USEPA Region 4, Science and Ecosystem Support Division. SESDPROC-512-R3
[7] Hudson River Natural Resource Trustees. 2001. Sampling and Analysis Plan Hudson River Fish Health Assessment, Phase 1: Field Sampling, Necropsy, Histopathology, Disease, Fish Age (Field Version). Final Public Release Version. October 3, 2001.

5. Length

   Fish length is measured using a measuring board on which the anterior end of a fish is placed against a stop at the beginning of a measuring scale. The fish should be measured with one mouth closed, and the body positioned on its right side with the head to the measurers left. Any one of three measurements can be taken: total, fork or standard length (Figure 1, Appendix A). Total length is the greatest length of a fish from its anterior most extremity (usually the mouth) to the end of the tail fin. For fish with a forked tail, the two lobes should be pressed together, and the length of the longest lobe should be taken. Fork length is measured from the anterior end of the fish to the tip of the middle rays of the tail. Standard length is the length of a fish from the anterior end of the fish to the tip of the middle rays of the tail. Standard length is the length of a fish from the anterior end to where the base of the median tail fin rays join the caudal peduncle. This spot can be located by bending the tail sharply. A crease should form where the tail fin rays end. Total length or fork length measurements are used most often. Determination of standard length is very difficult on some species. Record the length and type of length measurement on the data sheet.

6. Weight

   Spring balances or electronic digital scales are generally used to weigh individual fish. Fish can be weighed by themselves, or by placing them in a container of water. Taking the weight in water reduces error due to fish movement, but may not be practicable for large fish. Large numbers of fish can be weighed in bulk if individual weights are not needed (e.g., for population studies).

   Because most fish maintain near-neutral buoyancy in water, their specific gravity is close to 1.0 and body volume is proportional to weight. Therefore, the amount of water displaced in a container can also be used to determine weight. Record the weight to the nearest gram on the data sheet.

7. Preparation for further processing

   Pass forage fish collected for chemical analysis onto Station 2.

   Fish to be processed on-site for external and internal morphology, necropsy, and tissue collection for aging, histopathology, and chemical analysis will be passed on to Station 2.

   Fish to be sent to an off-site laboratory for external and internal morphology examination, necropsy, and tissue collection, will be placed in an aerated dedicated holding tank until they are ready to be shipped. Fish will be shipped live for delivery within 24 hours of shipment. Completed chain-of custody forms and this SOP for external and internal morphology, necropsy, and tissue collection will be included with each shipment. The off-site laboratory will follow the procedures described for Stations 2 and 3, below.

EXTERNAL EXAMINATION (STATION 2)

The results of the external examination are to be recorded using the field form, which also serves as a guide for the examination. See Figure SOP 10-2 for a generalized diagram of bony fish anatomy.

Preparation

1. Prepare a clean surface for necropsies and tissue collections, and use clean instruments.

Procedure

1. Put on a fresh pair of nitrile gloves.

2. Remove the fish from the holding tank, acquire the corresponding individual fish data sheet and place the fish in a cooler of ice water to subdue the fish.

3. Euthanize the fish by cervical dislocation.

4. Conduct the external morphological examination and necropsy, using the field form to record the results:

   a. *Body shape and appearance*. Record any abnormalities such as spinal curvature, swollen abdomen, protruding eyes, scars, lesions, parasites, tumors, or any other abnormalities.

   b. *Head appearance*. Record any head abnormalities, such as tumors, lesions, scars, or parasites.

   c. *Eye appearance.* Record fish with protruding or missing eyes, or other eye abnormalities.

   d. *Fin clips and tags.* Record and describe fin clips and/or tags (other than the Floy tag inserted by the collection crew).

   e. *Operculum.* Observe and record the condition of the operculum.

   f. *Gills.* Record and photograph (if possible) any obvious parasitism or morphological abnormalities, including color and integrity.

   g. *Sex.* Record, if possible from external features, the sex.

   h. *Other.* Prepare wet mounts of gill, fin and mucous collected from areas with visible external lesions and examine for abnormalities. Record and photograph (as appropriate) any other distinct physical anomalies.

5. Take photographs of anomalies as determined by the lead pathologist.

6. Place the fish on a new sheet of aluminum foil for internal necropsy and tissue collection.

After completing the external examination of forage fish collected solely for chemical analysis, individually wrap each fish from a sample in aluminum foil (shiny side out). Place all of the fish of a sample in a resealable plastic bag labeled with the sample number. Seal the bag and place it in a second, labeled, resealable plastic bag. Place the sample on ice. Ship forage fish samples for chemical analysis to the laboratory providing these services for next day delivery.

Include a completed chain-of-custody form with each shipment in accordance with field SOP 09.

INTERNAL NECROPSY AND TISSUE COLLECTION (STATION 2)

Note: The procedure for collecting scales or spines for age analysis and fillets for contaminants analysis is described below (Station 3).

This section describes the procedures for conducting the internal necropsy and collecting fish tissue samples for storage and shipment to laboratories for analysis. All histopathological samples will be placed in labeled cassettes. A single, labeled bottle of Dietrich's fixative will be used for the histopathological samples from each fish.

Tissues will be collected from each fish sample for the human health assessment (catfish and largemouth bass are the target species). One sample of each forage fish species collected from the embayment will be selected for tissue collection. Tissues collected for pathology will be preserved in Dietrich's solution and stored in bottles labeled with each fish's unique identifier, the organ from which the tissue was collected and the tissue collection date. Fillets will be individually wrapped in aluminum foil (shiny side out), placed in labeled resealable plastic bags and stored on ice for shipping. Scales, spines and otoliths will be placed in scale envelopes with each fish's unique identifier and the collection date.

The following tissues will be collected from each fish processed for tissue collection:

- spleen (histopathological analysis)
- liver (histopathological analysis)
- gonad (histopathological analysis)
- head kidney (histopathological analysis)
- trunk kidney (histopathological analysis)
- fillet (contaminant analysis)
- scales, spines and otoliths (age analysis).

Preparation

1. Check balance calibration using a standard weight and re-calibrate if necessary.
2. Prepare a label for each fish using the unique identification number given during Station 1 and that will be easily visible in photographs.
3. Prepare all sample containers and labels.
4. Prior to reuse, decontaminate all re-useable sampling equipment according to SOP 12. Wrap decontaminated equipment in clean aluminum foil.

Procedures

1. Verify sample container labels against fish species and Floy tag number. Verify that all equipment is new (one-time use equipment) or decontaminated and sterilized (re-useable equipment).

2. Position the fish with the left side up, ventral side closest to the examiner.

3. Wipe the entire left side of the fish with a disposable towel soaked in laboratory grade organic free water.

4. Using disposable or freshly decontaminated and sterilized dissection scissors and forceps, make the following cuts (using care not to puncture any internal organs):

a. Cut a small vertical (perpendicular to the backbone) incision approximately 1 cm anterior to the vent at the ventral axis.

b. Cut from this vertical incision to the base of the operculum along the ventral axis.

c. Cut from both ends of the ventral axis incision to the lateral line.

d. Cut along the lateral line and remove the left side of the musculature of the fish to fully expose the internal organs.

5. Record any abnormalities on the peritoneal side of the musculature removed from the fish. Note any discoloration or hemorrhages in the peritoneal cavity.

6. Determine the sex of the fish. Inspect the gonads and note any unique features or abnormalities.

7. Record the condition of the swim bladder.

8. Inspect the pyloric caeca for discoloration, abnormal shape, tumors, disfiguring features, hemorrhages, and its size relative to the stomach.

9. Inspect the intestine for discoloration, abnormal shape, tumors, disfiguring features, and hemorrhages.

10. Process the liver:

a. Use newly decontaminated dissecting equipment to remove the liver by cutting the connective tissue and vasculature that attaches the liver to the viscera and place the liver on a cutting board covered with clean aluminum foil prior to dissection.

b. Carefully separate the gall bladder from the liver and inspect it for discoloration and whether or not it is distended due to fluid accumulation. Grasp the cystic duct with a hemostat. Cut the cystic duct between the hemostat and the liver taking care not to touch the liver with the scissors. Care should also be taken not to spill any bile onto the liver.

c. Remove any non-liver tissue from the surface of the liver and carefully inspect the liver for any lesions or abnormalities, including discoloration, abnormal shape, tumors, disfiguring features, and hemorrhages.

d. Place the liver in an aluminum weigh boat and weigh (to the nearest 0.01 g).

e. If there are no gross lesions visible, samples for histopathology will be taken from three different areas of the liver. The samples should not exceed one centimeter in thickness and they should be removed from the right side of the liver, from the center, and from the left side of the liver (see Figure 4). If possible these samples should be identified as to their origin (right, center or left) and placed in cassettes or gauze bags as appropriate to the size of the sample. These samples should be placed in a container with Dietrich's

fixative for histopathology (along with other tissues from the same fish for histopathology).

If there are gross lesions visible in the liver, sampling will have to be adapted to the site of the gross lesion or lesions. It is difficult to make firm rules for sampling in this case. As a general rule try to sample the same areas as are sampled in the liver with no gross lesions. For example, if a discrete gross lesion is present on the right side of the liver, sample the gross lesion and then take sections from the left side and center of the liver in addition for consistency. Guidelines for sampling tissue when gross lesion(s) are present are as follows. If there is more than one lesion and the lesions are discrete, sample each lesion taking care to leave an amount of "normal" liver issue around the lesion. Estimate and record the size and location of each lesion along with other discernible features (color, texture, shape). Number the lesions in order with the suffix "EH1," "EH2," etc., after the species identifier and Floy tag number identifier of the sample identification code (see Section 5.7.2). Place each lesion in a separate cassette or gauze pouch as appropriate to size and label that container with the assigned letter. Place these cassettes or pouches in a sample bottle that contains Dietrich's fixative (along with the other tissues from the same fish for histopathology).

If the liver has a gross lesion that is not discrete and involves over 50% of the liver, describe the lesion as stated above with the location and size as well as observations of color, texture, and any other unique features. Remove the entire lesion and some adjacent "normal" liver for histopathology if this sampling can be done without compromising the amount of liver needed for contaminant analysis. With a sharp scalpel make incomplete slices into the liver lesion perpendicular to the "normal" liver at one centimeter intervals to assure adequate fixation of the tissue. Place the liver lesion in a sample bottle that contains Dietrich's fixative (along with other tissues from the same fish for histopathology).

If the liver has a lesion which involves the entire liver diffusely, then sample the liver as described for a liver with no gross lesions. In this case the description of the appearance should be as detailed as possible. If the liver exhibits a variety of features, try to include as many of the different features as possible in the samples. Place each sample in a separate cassette or gauze pouch appropriately labeled as to the location of the sample (right, center, or left). If necessary, take additional samples to include all the various features of the lesion and label them appropriately. Place these specimens in a sample bottle that contains Dietrich's fixative (along with other tissues from the same fish for histopathology).

9. Collect the spleen samples:

a. Use newly sterilized dissecting equipment (scalpel, razor blade, forceps), or sterile disposable equipment.

b. Remove the spleen from the visceral mass using a scalpel and forceps.

c. Place the spleen on a new piece of weigh paper, blot dry with a Kimwipe™, and weigh (to nearest 0.01 g).

d. Note and photograph any morphological abnormalities, including discoloration, abnormal shape, tumors, disfiguring features, and hemorrhages. Remove any gross histopathological lesions and place in a sample bottle that contains Dietrich's fixative (for histopathological analysis).

e. Place the remainder of the spleen in a sample bottle with Dietrich's fixative (for histopathological analysis)

10. Collect the gonad samples:

a. The dissecting equipment used for the previous procedure can be re-used for this procedure. Wipe the equipment clean before proceeding.

b. Remove the gonads from the visceral mass.

c. Place the gonads in an aluminum weigh boat and weigh.

d. Note and photograph any morphological abnormalities (lesions, tumors, *etc.*). Remove any gross histopathological lesions and place in a sample bottle that contains Dietrich's fixative (for histopathological analysis).

e. Place the gonads in a sample bottle with Dietrich's fixative (for histopathological analysis).

11. Collect the head and trunk kidney samples:

a. Use newly sterilized dissecting equipment (scalpel, razor blade, forceps), or sterile disposable equipment.

b. Note and photograph any morphological abnormalities (lesions, tumors, *etc.*). Remove any gross histopathological lesions and place in a sample bottle that contains Dietrich's fixative (for histopathological analysis).

c. Remove 1 cm of the anterior-most portion of the head kidney.

d. Place the 1 cm section of head kidney in a sample bottle with Dietrich's fixative (for histopathological analysis).

e. Remove 1 cm of the posterior-most portion of the trunk kidney.

f. Place the 1 cm section of trunk kidney in a sample bottle with Dietrich's fixative (for histopathological analysis).

g. Pass fish on to station 3 with the data sheet and the jar of tissues with fixative.

SPINES, SCALES, AND FILLET COLLECTION (STATION 3)

1. Check Floy tag against data sheet for agreement

2. Collect spines from the left pectoral of each catfish:

a. Apply gentle pressure, then twist the spine, dislocating it from the socket, and complete the operation by tearing the disarticulated spine from the skin. (Try to dislocate the spine, not break it.)

b. Place the spine in a properly labeled scale envelope.

c. For duplicate spine samples, remove the right pectoral fin spine and place in a second scale envelope with the duplicate sample label.

d. For age analysis, cut a cross-section through the articulating process, if present. If the articulating process is not present, cut sections through the shaft.

3. Collect otoliths from each catfish:

a. Grasp the head firmly and cut the top of the skull slightly behind the eyes back to the upper edge of the gill cover. If the cut is made correctly, the large sacculus otoliths should be exposed behind the brain. If not, carefully probe around the area until the otolith is located.

b. Gently remove both large otoliths with forceps, clean them, and place in a clean, labeled envelope.

4. Collect scales from largemouth bass, bluegill, and the forage fish:

a. Before collection, gently scrape the target area to remove mucus and epidermis.

b. Scrape at least ten scales from the skin of the fish just posterior to the longest point of the pectoral fin, below the dorsal line. Lateral line scales are not to be collected.

c. Remove scales by scraping towards the head, or by firmly pressing a knife point on a scale and pushing towards the tail.

d. Place the scales into a properly labeled scale envelope.

e. For age analysis, identify the scale annuli using criteria described in Carlander, 1961[8].

5. Collect fillet samples (catfish and largemouth bass only):

a. Select the largest fish above the legal limit in each sample for fillet processing. In the event that no fish exceed the legal limit, confer with USFWS and TRC to determine how many fish to process for chemical analysis.

b. Use either dedicated or decontaminated reusable equipment (scalpel, fillet knife, forceps) for this procedure.

c. Turn the fish over so the right side is up.

d. Wipe the outside of the fish with a disposable towel soaked in laboratory grade organic free water.

e. For catfish, remove skin from the area to be filleted. For largemouth bass, remove scales from the area to be filleted.

f. Make a cut along the ventral midline of the fish from the vent to the base of the jaw.

g. Make a diagonal cut from base of cranium following just behind gill to the ventral side just behind pectoral fin.

[8] Carlander, K.D. 1961. Variations in re-reading walleye scales. *Transactions of the American Fisheries Society* vol. 90:230-231.

h. Remove the flesh and ribcage from one-half of the fish by cutting from the cranium along the spine and dorsal rays to the caudal fin. The ribs should remain on the fillet.

i.

Wrap the fillet in aluminum foil (shiny side out) and place in a labeled resealable plastic storage bag. For each composite sample, all fillets will be placed in the same, labeled Ziploc bag.

6. Ship tissue samples to appropriate laboratory and include chain-of custody forms with each shipment.

7. Place the Floy tag in the histopathology sample jar and seal the jar with parafilm.

8. Stockpile all used chemicals and all used tissues for appropriate disposal.

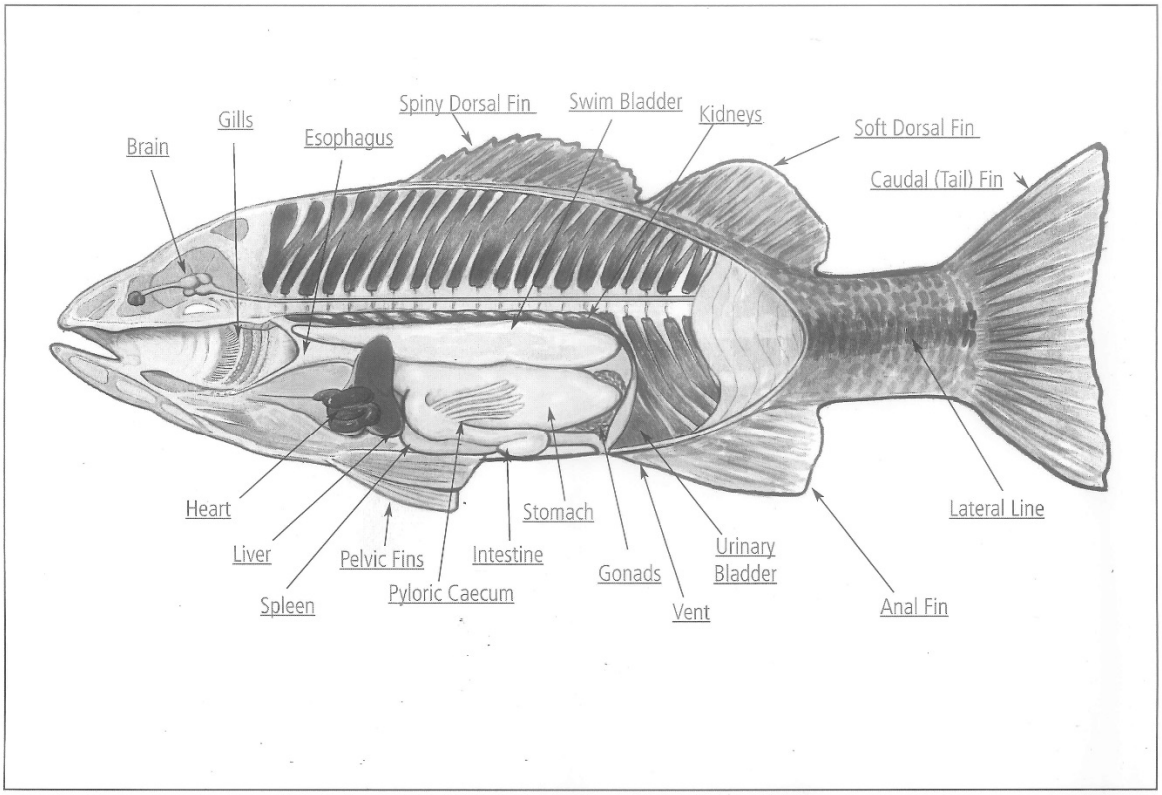
Prepare chain-of-custody documentation for each sample. As feasible, all samples must be shipped to the laboratory the same day they are collected. Fish from multiple collection locations may be stored in the same cooler as long as each sample is stored in a clean separate plastic bag.

Collected samples should be stored in a secure location to preclude conditions, such as desiccation, which could alter the properties of the sample. Samples shall be custody sealed during long-term storage or shipment. Collect samples are in the custody of the sampler or sample custodian until the samples are relinquished to another party.
If the samples are transported by the sampler, they will remain under his/her custody or be secured until they are relinquished. Chain-of-custody documents shall be filled out and remain with the samples until custody is relinquished. All shipping documents, such as bills of lading, will be retained by the project leader and stored in a secure place.

FIGURE SOP 10-1
External Examination, Internal Examination and Sample Collection Process Flow

Station	Procedure
1	Remove fish from holding pen and rinse with pesticide free water
	Start Fish Data Sheet – record Floy Tag number and attach an identification label
	Identify species and sex
	Measure length
	Weigh fish
	If shipping fish to lab for necropsy and tissue collection, prepare fish for shipping, prepare Chain-of-custody paperwork
2	Euthanize
	Prepare a label that records sample number and Floy tag number
	Conduct external necropsy
	Collect and wet mount gill, fin and mucous samples
	Open the body cavity
	Inspect the swim bladder
	Process liver
	Process spleen tissue
	Process gonad tissue
	Process anterior kidney
	Process posterior kidney
3	Remove left pectoral spine from catfish
	Remove otoliths from catfish
	Remove scales from other fish
	Collect fillets from catfish and largemouth bass

FIGURE SOP 10-2
Generalized Diagram of Bony Fish Anatomy



SITE-SPECIFIC STANDARD OPERATING PROCEDURE (SOP) 11
MANAGEMENT OF INVESTIGATIVE WASTE
CRAB ORCHARD NATIONAL WILDLIFE REFUGE

Given that the investigation will be conducted in a publicly accessible wildlife refuge, the utmost care must be given to the management of general refuse. In addition, various Investigation-Derived Waste (IDW), including PPE, decontamination fluids and sediments, soil cuttings, drilling fluids, and purged groundwater will be generated during the investigation and must be handled appropriately.

GENERAL

Document all deviations from the procedures required by this SOP in a standard bound field logbook (logbook). In addition, implement corrective action as described in Worksheets #6, #14, #31-1, and #32-1 of the Quality Assurance Project Plan (QAPP). If corrective action is not required, describe the basis for that determination in the logbook.

PRIOR PLANNING AND PREPARATION

The following activities must be undertaken prior to managing IDW:

i) Review the Work Plan, Quality Assurance Project Plan (QAPP), and the Health and Safety Plan (HASP) requirements.

ii) Requisition all necessary equipment and assemble all equipment and supplies needed. Ensure equipment is in proper working condition and calibrate as needed, and note such in a bound field logbook (logbook).

EQUIPMENT NEEDS

The following is a general list of equipment; additional equipment may or may not be required.

- steel trash receptacle
- 55-gallon steel drums
- Super Sacs
- rolloff storage container
- plastic or steel tanks for bulk storage
- polyethylene spill berm
- polyethylene sheeting
- tarp
- indelible markers
- paint markers
- logbook
- PPE as specified in the HASP

FIELD PROCEDURES

A. General Refuse

All general refuse, including office trailer waste, plastic sheeting, buckets, paper bags, etc., must be removed from the Refuge. Arrange for a steel trash receptacle and refuse pick up during investigative work with a local refuse disposal contractor. Collect general refuse in plastic bags and dispose in a trash receptacle staged at the office trailer.

A. Investigation-Derived Waste (IDW)

Transfer decontamination fluids and sediment, drill cuttings, and drilling fluids to Department of Transportation (DOT) approved 55-gallon steel drums (or alternatively in Super Sacs) and stage at the temporary decontamination facilities or investigative locations. Move temporarily containerized sediment, drill cuttings, and drilling fluids to a central IDW staging area upon completion of the investigative work in the area but at a frequency of no less than once per week. Inspect the central IDW staging areas weekly (during periods of active fieldwork).

General IDW containment requirements include the following:

- Temporarily containerize drill spoils and drilling fluids at each location in DOT-approved steel 55-gallon drums; alternatively, Super Sacs may be used. Clearly and conspicuously label these containers with labels and indelible markers. Include a description of the contents (e.g., drill cuttings from boreholes SB-1, SB-2, etc.), PEST AUS location, and the date of generation. Record this information in the logbook. Because the amount of IDW generated at DPT boreholes is minimal (a few pounds per location), consolidate drill cuttings from separate DPT boreholes into a single container.
- Place soil cuttings into drums or Super Sacs and temporarily stage in a designated area of the PEST AUS (where work is performed). Transport these containers of soil cuttings from the temporary staging area to the central IDW staging area no less than weekly. At the main staging area, soil cuttings may be transferred into lined rolloff storage containers, if warranted by the volume of soil cuttings generated. Cover the rolloff containers with tarp nightly and during precipitation events. Reuse emptied containers. Maintain and record a log of the source of the IDW put into each rolloff box in the logbook.
- Temporarily stage purged groundwater from well development and sampling activities in tanks or drums at the point of generation. Transport the purged groundwater to the IDW staging area and store in in steel drums, or bulk in larger plastic or steel tanks pending characterization and disposal. Segregate any purged water classified as hazardous waste for appropriate handling.
- Collect and transfer decontamination solids and sediments into drums or the lined rolloff boxes previously noted.

- Collect decontamination fluids in plastic tanks or 55-gallon drums and transport to the IDW staging area no less than weekly. Decontamination fluids may be bulked in larger plastic or steel tanks at the IDW staging area as previously noted. Clearly and conspicuously label the drums or storage tanks with paint markers with a description of the contents. Store decontamination fluids separately from other IDW fluids (i.e., purged groundwater and drilling fluids).
- Decontaminate temporary storage containers using the same steps noted in Section B.1, *Drilling Rigs* of SOP 1 prior the removal from the Refuge.

Handle IDW in a manner to minimize the potential of spills. As a precautionary measure, construct secondary containment items consisting of a polyethylene spill berm around each of the storage tanks used to hold liquid IDW. Line rolloff boxes with polyethylene sheeting and cover with tarp when not being used or filled. Inspect the IDW tanks and roll-off boxes weekly and record in the field log book.

Manage IDW in a manner consistent with the protocols and procedures detailed in the document "Guide to Management of Investigation-Derived Wastes" (OSWER Publication 9345.3-03FS dated January 1992). As stated in the IDW guidance document: "*Site managers should not assume that a waste considered to pose a potential risk at a CERCLA site is a listed or characteristic RCRA hazardous waste. Until there is positive evidence (records, test results, other knowledge of waste properties) that the IDW is a RCRA hazardous waste, site managers should manage it in a protective manner (but not necessarily in accordance with Subtitle C requirements).*"

Routinely characterize the separate IDW streams for proper disposal. Collect representative samples of each waste stream and send to an environmental laboratory for waste characterization analyses. Following the results of waste characterization activities, as appropriate based on characterization data and waste medium, dispose IDW at a permitted Subtitle D facility with Illinois special waste approval, a Subtitle C disposal facility, or a publicly owned treatment works (POTW). Ensure that IDW is transported only to facilities that are in compliance with its permit. Remove IDW from the Site within 90 days of completion of field activities associated with the investigation.

Manifest any hazardous waste for disposal using an appropriate generator identification number. Obtain a generator identification number for the disposal of the IDW (subject to approval/issuance by the Illinois EPA) or include it under its existing generation identification number.

RECORDED INFORMATION

Record the following information in a field logbook:

- location and date of IDW generation
- contents of Supersack or 55-gallon drum
- source of IDW put in rolloff boxes

- description of weekly IDW tank and rolloff box inspections

It is not sufficient to write in the logbook "IDW was managed in accordance to this SOP." Rather, the logbook should detail the steps and materials used for all the requirements as noted above.

FOLLOW-UP ACTIVITIES

Complete the following activities at the end of each day:

i) Prior to leaving a work area make sure equipment and supplies are secure and the work area is cleaned up and secure.

ii) Ensure field logbook and field forms have been updated and are complete.

iii) Return keys and cleaned equipment to the main staging area.

STANDARD OPERATING PROCEDURE (SOP) 12
DECONTAMINATING RE-USEABLE DISSECTION AND SAMPLE COLLECTION TOOLS

MATERIALS

- Clean potable water.
- HPLC (High Performance Liquid Chromatography)-grade or pesticide-grade methanol.
- Analyte-free distilled water, ASTM (American Society for Testing and Materials) Type-II reagent grade water, or HPLC-grade water.
- Polytetrafluoroethylene (PTFE) wash bottle.
- Alconox soap.

DECONTAMINATION (FOR EQUIPMENT USED TO OBTAIN SAMPLES FOR CONTAMINANT ANALYSIS)

1. Wash in Alconox soap solution.
2. Rinse using clean potable water.
3. Rinse thoroughly with methanol.
4. Rinse thoroughly with laboratory grade organic free water from a PTFE (e.g. Teflon®) wash bottle.

STORAGE

Decontaminated tools will be stored in aluminum foil wrapping to protect them from exposure to airborne contamination.

FWS Addendum to ENTRIX SOP #0025 002
29 April 2010 (modified by TRC 3 June 2014)

This addendum summarizes modifications to ENTRIX SOP #0025 002 *Standard Operating Procedure for Collecting Sediment Samples* which shall be incorporated into procedures for sediment sampling to support the Work Plan for an Engineering Evaluation/Cost Analysis (EE/CA) for the Pesticide Contamination at Area 7 Pesticide Area, Additional and Uncharacterized Sites Operable Unit.

Section 1 (3rd paragraph) – Sediment samples are collected using a core sampler *wherever possible*, and samples are placed into clean labeled jars with minimum headspace and packed in ice (in coolers) during transportation to the laboratory. *If only the upper 6 inches of the sediment column is required for analysis (e.g. no more than 6 inches of sediment are present, or only 6 inches of sediment are required under the scope of work) and the sample cannot be recovered using a coring tool, a stainless steel petite ponar dredge may be used to recover the sample.* If no water is present in sampling locations that are only temporarily inundated, then a trowel will be used to collect the sediment sample.

Section 4.6 (2nd bullet) – Samples for analysis of organic compounds should be collected with stainless steel *or aluminum* liners *or core tubes*, cutting heads, retainers, extruders, knives, and compositing bowls should be used. If a stainless steel extruder is not available, a brass *or teflon* extruder may be used.

Section 5.4 (added) – The piston core sediment sampler consists of a stainless steel or aluminum core tube fitted with a "T" handle, and a Teflon piston attached to a steel cable. The piston is placed at the base of the core tube, and is pulled up the tube with the steel cable as the core tube is pushed into the sediment. The piston creates suction that holds the sediment sample in the core tube as it is retrieved from the sediment. The length of the core tube is limited only by what can be practically managed in the field environment, so the piston core sampler is ideal for sampling the full thickness of the sediment column. The piston core sampler can be used in shallow (<20 feet) waters.

Section 5.5 (added) – The Russian peat core sampler consists of a 20 inch long steel chamber with a sharp end and a rotating steel blade. The corer is pushed into the sediment using steel rods and a "T" handle, with the blade in the "closed" position. Once the target sampling depth is reached, the handle is turned a half round to turn the blade. The blade cuts the sediment sample into the chamber and closes the sample in. The corer is then withdrawn from the sediment using the handle. The Russian peat corer is a discrete interval sampling device, which allows for sampling of the full thickness of the sediment column, even if more than 20 inches of sediment are present. The Russian peat corer can be used in shallow (<15 feet) waters.

Section 5.6 (added) – The petite Ponar dredge consists of two steel jaws held open with a trip bar, and a top surface covered with mesh screen to allow the passage of water through the sampler as it is lowered to the sediment surface. The sampler is lowered to a point just above the sediment surface. The dredge is then dropped sharply into the sediment to release the trip bar and close the sampler. Water drains through the screens on the top of the dredge. The petite Ponar dredge can be operated at any water depth.

FWS Addendum to ENTRIX SOP #0025 002
29 April 2010 (modified by TRC 3 June 2014)

Section 6 (bullet list) – add the following items to the bullet list:

- Piston core sampler
- Stainless steel or aluminum core tubes
- Russian peat corer
- Petite Ponar dredge
- Aluminum foil or steel inserts for HDPE end caps
- Sheet metal shears

Section 8.1 (2nd sentence) – Any adjustment of sample locations must be coordinated with the FWS.

Section 9.1 (1st and 2nd sentences) - Refer to *SOP-02* for decontamination of equipment. All *non-dedicated, non-disposable* sampling equipment (core samplers, liner tubes, caps, eggshell catchers, extruders, etc.) must be cleaned with a laboratory-grade detergent (phosphate-free detergent) and then rinsed with laboratory-grade distilled water, followed by a laboratory-grade organic water rinse.

Section 9.5 (1st sentence) - The core sampler should be assembled using the appropriate contact material *(plastic, stainless steel, or aluminum)* as described in Section 4.6.

Section 11.2 (1st paragraph, 3rd sentence) – *In the field notebook and/or appropriate field data form,* record the date and time of photographs, shot orientation, description of the shot, and the camera operator.

Section 11.3 – If called for in the *Work Plan for an Engineering Evaluation/Cost Analysis (EE/CA) for the Pesticide Contamination at Area 7 Pesticide Area, Additional and Uncharacterized Sites Operable Unit* and water is present, collect surface water samples and ancillary water chemistry data (see SOP 0025-003).

Section 11.4 (1st sentence) - If no surface water samples are being collected at the location but water is present, collect ancillary water chemistry data *(SOP 0025-003)* and record the results *in the field logbook and/or the appropriate field data form.*

Section 11.5.1 (replaced) – Sediment sampling intervals and depths shall be as specified in the *Work Plan for an Engineering Evaluation/Cost Analysis (EE/CA) for the Pesticide Contamination at Area 7 Pesticide Area, Additional and Uncharacterized Sites Operable Unit.* If the sediment depth is less than that specified in the Work Plan (e.g., six inches thick), the sampling depth shall not extend below the sediment (depositional) zone. Multiple samples collected in close proximity may be necessary to obtain sufficient sample mass for chemical analysis.

Total depth of sediment shall be noted in the field notebook. Total sediment depth shall be assessed based on core/trowel penetration resistance and visual examination of coloration and grain size of core/trowel contents. All observations shall be documented in the field notebook.

If the sediment sampling depth specified in the Work Plan exceeds the capacity of the manual sampling devices discussed in this SOP, then alternative procedures (e.g., vibracore sampling) shall be discussed and approved by FWS.

Section 11.5.2 – Deleted

Section 11.6 (par. 2, 3rd sentence) – Insert the trowel into the sediment approximately 6 inches *(not to exceed the sediment depositional layer)* and place material into homogenizing vessel.

Section 11.6.1 (added) – measure the depth of water using a weighted tape. Record the water depth in the field notebook to the nearest 0.1 foot (or to the nearest 0.01 foot if conditions allow).

Section 11.7 (2nd sentence) - Press the Wildco core barrel, *piston core sampler,* (or equivalent) into the sediment with a constant pressure.

Section 11.8 (add to end of paragraph) – When using the piston core sampler, the core tube is the equivalent to the core liners of the Wildco and K-B corer. When the core tube is brought to the surface, one person will hold the device vertically while a second person immediately caps the bottom of the core tube. The tube will then be cut to a length just above the top of the sediment, and the piston assembly removed. A cap is then placed on the top of the tube. Label each core with the location ID, the top of the sample, and the sample length.

Section 11.9 (1st sentence) - Decontaminate all *non-dedicated, non-disposable* sampling equipment, including the spatula, *the piston*, the *Wildco* core barrel, and nose piece.

Section 11.9.1 (added) – Core samples contained in stable liners may be transported to shore for logging and processing (for laboratory analysis). Cores that are not processed immediately upon collection will be capped, sealed, and the exterior surface cleaned to prevent cross contamination. Cores will be kept in an upright position during transport, and placed on ice. Processing of the samples may include either core extrusion (Sections 11.10 through 11.13) or cutting the core liner lengthwise (Section 11.13.1). Samples collected with a Russian peat corer, or a Ponar dredge will be logged and processed at the time of collection (Sections 11.13.2 and 11.13.3).

Section 11.13.1 (added) – The liner may be cut lengthwise using sheet metal shears, or equivalent cutting tool, to expose the full sediment core. Cut the full length of the tube at two locations, approximately 120 degrees apart. Remove the "window" from the core barrel. If VOC samples are needed, collect these directly from the core barrel. Log the sample in accordance with the directions presented in SOP-03. Transfer the sediment material for each sample interval into separate stainless steel mixing bowls, and process the samples as described in Section 11.14.

Section 11.13.2 (added) – When using a Russian peat corer, press the sampler into the sediment with the blade in the "closed" position. Once the desired sample depth is attained, rotate the blade by turning the handle clockwise. This causes the sharp edge of the sample chamber to cut through the sediment and seal against the cover plate. The sample chamber is then removed from the sediment. At the surface, the core sample is exposed on the cover plate by rotating the core tube counter clockwise. Samples collected with the Russian peat corer will be logged and processed for laboratory analysis at the time of collection. The material for each analytical sample will be placed directly into a steel mixing bowl. Process samples as described in Section 11.14. Decontaminate the peat corer as described in SOP-02, and continue sampling. Start sampling from the sediment surface and continue to collect samples at 20-inch intervals until refusal of the sampler is encountered.

Section 11.13.3 (added) – When using a petite Ponar dredge, attach a braided nylon cord or steel cable to the top bracket. Open the jaws of the dredge and set the trip bar so that the sampler remains open when lifted with the cable. Slowly lower the dredge to a point just above the sediment surface, taking care not to disturb the sediment. Drop the sampler sharply into the sediment to release the trip bar, allowing the jaws to snap shut. Retrieve the sampler slowly, and decant water through the screens on the top of the sampler. Open the dredge and transfer the sediment into a stainless steel mixing bowl or bucket. Repeat these steps one or more times, until enough sediment has been collected to fill the sample containers. Note the number of times the sampler is deployed at each location in the field notebook and/or appropriate field form. Process samples as described in Section 11.14. Decontaminate the Ponar dredge in accordance with SOP-02, and continue sampling.

Standard Operating Procedure for Collecting Sediment Samples

1 Scope & Summary

This standard operating procedure outlines techniques for collecting sediment samples from shallow freshwater streams, ponds, inland lakes, drainage pathways and ephemeral water bodies.

This method is described for deployment from a small, stable boat or on foot.

Sediment samples are collected using a core sampler, and samples are placed into clean, labeled jars with minimum headspace and packed in ice (in coolers) during transportation to the laboratory. If no water is present in sampling locations that are only temporarily inundated, then a trowel will be used to collect the sediment sample.

2 Reference Documents

ASTM (E1391-90) *Standard guide for collection, storage, characterization and manipulation of sediments for toxicological testing*. American Society for Testing and Materials, Annual Book of ASTM Standards. vol. 11.02, Philadelphia, PA.

Baudo, R (1990) *Sediment sampling, mapping and data analysis*. In Sediments: the Chemistry and Toxicology of In-place Pollutants. R Baudo, J Giesy & H Muntau (eds.). Lewis Publishers. Chelsea, MI pp. 15-60.

Mudroch, A & S MacKnight (1994) *Bottom sediment sampling. In Handbook of Techniques for Aquatic Sediments Sampling*. Second Edition. A Mudroch & S. MacKnight (eds.) Lewis Publishers, Ann Arbor, MI pp. 29-96.

USEPA (1985) *Sediment sampling quality assurance user's guide*. EPA 600/4/85/048. U. S. Environmental Protection Agency, Environmental Monitoring and Support Lab., Las Vegas, NV 114 pp.

3 Significance and Use

The samples collected by this method are suitable for chemical characterization, but may not be suitable for biological analyses such as evaluation of the benthic macroinvertebrate community, or physical analyses (e.g., grain size). This method is best for studies where sample replication is desired.

4 Potential Interferences

4.1 The sediment surface can be easily disturbed during sample collection. This disturbance will increase the turbidity of the overlying water and might cause errors in the analytical chemistry data. Therefore, caution must be exercised, especially when using the T-handle, to avoid disruption of the sediment-water interface.

4.2 The presence of headspace (bubbles) in sample containers might cause errors in samples to be analyzed for volatile substances.

4.3 Residual sediment might remain in the core sampler and contaminate subsequent samples. To prevent contamination, all sampling gear must be thoroughly decontaminated between sample locations.

4.4 Large objects (e.g. stones, sticks etc.) might obstruct the core barrel and prevent successful sample collection. If possible, sample locations should be selected to avoid these objects.

4.5 It might be difficult to penetrate very firm sediments (e.g. clay, gravel, or sand) with the core sampler. A pre-sampling site inspection should be conducted to evaluate the suitability of the sample gear for collecting samples.

4.6 The materials of which the core sampler is composed could contaminate the samples. To minimize potential contamination, the equipment that contacts the sample should be assembled using the materials least likely to result in contamination. For example:

- Samples for metals analyses should be collected with plastic equipment. The core samplers are built of stainless steel, however, plastic liners, cutting heads, retainers, extruders, knives and compositing bowls should be used.
- Samples for analysis of organic compounds should be collected with stainless steel liners, cutting heads, retainers, extruders, knives, and compositing bowls should be used. If a stainless steel extruder is not available, a brass extruder may be used.

4.7 Care must be taken to avoid having the sample or sample container come into contact with the ungloved hand or clothes of the sampler. The sampling team must always wear clean disposable sampling gloves appropriate for the specific media and constituents being analyzed. During sampling, if the sample container or sample comes into contact with the ungloved hand or clothes of the sampler, it is assumed that the sample has been cross-contaminated and a new sample container must be used or the location must be re-sampled.

5 Apparatus

5.1 The Wildco sediment core sampler (or equivalent) consists of a steel cylinder fitted with a sharp nose piece and a “T” handle. This cylinder (core barrel) contains a replaceable plastic (cellulose acetate butyrate) or stainless steel liner that stabilizes the sediment sample, and a (eggshell) core retainer that prevents the sample from exiting the liner. A check valve above the core barrel allows air and water to escape when the device is pushed into sediment, but closes during retrieval to prevent the sample from escaping. The Wildco sampler (or equivalent) can be used in shallow (<15 feet) waters.

5.2 The K-B sediment core sampler (or equivalent) has the same barrel, liner, nosepiece, and core retainer. The check valve assembly has been modified to avoid backpressure within the core barrel. This design prevents the K-B core sampler from disturbing the sediment-water interface. The K-B corer also has a heavy weight (36 kg) affixed below the check valve that facilitates penetration into the sediments. It has no T-handle to push it into the sediments, but relies on weight. The K-B corer is operated with an 1/8 inch aircraft cable. It is designed to free-fall the last 30 feet (10 m) of the water column. A messenger is used to close the check valve once the core has penetrated the sediments. The K-B corer (or equivalent) is suitable for water depths < 600 feet (provided enough cable is attached).

5.3 If no water is present in ephemeral water bodies, then a metal or plastic trowel will be utilized to collect the sample. The composition of the trowel will be dependent upon the type of constituents to be analyzed (Section 4.6).

6 Materials

- Wildco core sampler (or equivalent) (core barrel with check valve and T- handle);
- K-B core sampler (or equivalent) (20-inch core barrel with check valve, aircraft cable and winch);
- core liners with end caps: for organic analyses stainless steel liners and end caps will be used, and for inorganic analyses cellulose acetate butyrate (CAB) liners and

HDPE end caps will be used. (Note: end caps will only be used if field conditions require that sample cores be transported prior to extrusion);

- core nose pieces;
- core retainers;
- core extruders;
- spatulas or knives;
- compositing vessels;
- sample containers with lids;
- sample labels;
- sample trowel;
- dissolved oxygen meter and probe with depths pre-marked on cable (YSI Model 57 DO meter (or equivalent) with 25 feet of (unmarked) cable can be rented from Hazco);
- pH meter and probe;
- specific conductance meter and probe with depths pre-marked on cable (YSI Model 33 conductivity meter (or equivalent) with 25 feet of (unmarked) cable can be rented from Hazco);
- temperature meter and probe with depths pre-marked on cable (YSI Model 57 DO meter (or equivalent) with 25 feet of cable can be rented from Hazco);
- waterproof marking pens;
- coolers (with ice) for sample storage;
- core-holding buckets;
- sample data forms/clip board;
- field logbook;
- decontamination supplies;
- nitrile gloves;
- pipe wrench (minimum 14 inch) to disassemble corers;
- miscellaneous tools (vise grip pliers, shackles, wrenches, plumber's Teflon thread tape, utility knife);
- messenger for K-B corer;
- digital camera and electronic storage devices; and
- personal & safety gear.

7 Hazards & Precautions

7.1 Field-collected sediments might contain potentially toxic materials, and thus should be treated with caution to minimize exposure to workers. Waterproof clothing (waders) and gloves are recommended.

7.2 The project Health and Safety Plan must be reviewed to identify further hazards, precautions and safety procedures.

8 Sample Preparation

8.1 Sample locations may be adjusted on-site as deemed necessary by the location of sedimentation zones, physical obstructions, or other factors. Any adjustment of sample locations must be coordinated with the FWS and NewFields. A pre-sampling site inspection should be conducted to evaluate whether these procedures are feasible (Section 4.5) for sampling the desired locations.

8.2 Appropriate new sample containers must be obtained from the analytical laboratory or a commercial supplier. The analytical procedures must be reviewed to identify the proper sample container material, size, and preparation.

8.3 The Field Team Leader must read the Quality Assurance Project Plan before field sampling procedures are undertaken to understand how many and what type of QA/QC samples are required.

8.4 The Field Team Leader and sampling staff must read the Health and Safety Plan prior to sampling to review applicable safety requirements.

9 Preparation of Apparatus

9.1 Refer to SOP 0025-004 for decontamination of equipment. All sampling equipment (core samplers, liner tubes, caps, eggshell catchers, extruders, etc.) must be cleaned with a laboratory-grade detergent (phosphate-free detergent) and then rinsed with laboratory-grade distilled water, followed by a laboratory-grade organic water rinse. Because additional preparations (acid or solvent rinses) might be necessary for specific analyses, the analytical methods should be reviewed to identify additional requirements.

9.2 The field meters and probes should be tested and calibrated daily. The calibration results should be recorded in the maintenance log for each instrument and noted in the field logbook.

9.3 For sediment cores that will be transported prior to extrusion, slits should be cut in the end caps for the core tubes to allow air to escape, and prevent disturbance of the sediment cores (see Section 11.8).

9.4 The core samplers should be field-tested to ensure the check valves are working properly.

9.5 The core sampler should be assembled using the appropriate contact material (plastic or stainless steel) as described in Section 4.6.

10 Calibration & Standardization

10.1 The field meters (pH, dissolved oxygen, and specific conductance) must be calibrated according to the manufacturer's manuals on a daily basis. The results of the calibration should be recorded on the maintenance log for each instrument, and noted in the field logbook.

10.2 The sediment extruder should be calibrated to facilitate the removal of a pre-selected volume of sediment from the core liner. A pre-sampling field inspection (see Section 8.1) should be conducted to determine the practical minimum depth the corer will penetrate (see Section 4.5) into the sediments at the site. All sediment samples should then be collected to this (minimum) depth so the analytical results will be comparable.

10.3 The extruder post should be calibrated (marked) so that the amount of sediment extruded can be selected. This procedure ensures that the same amount of sediment is extruded from each core so that samples are consistent and comparable. A small snap-

type clamp can be used to mark the point of maximum extrusion so that the field personnel can focus their attention on capturing the surficial sediment layer as it is extruded. In some sediments this layer will be very flocculent and can easily be lost.

10.4 The K-B corer (or equivalent) is heavy, awkward to grasp, and relatively sensitive to jostling. It can't be operated with a hand-over-hand technique along the cable. Arrangements must be made to raise and lower it with a winch-pulley-roller system from a davit or tripod. The deployment design should be pre-assembled and tested before sampling is attempted. The deployment device will be specific to the actual boat, barge, or other watercraft used, and cannot be prescribed in this SOP.

11 Procedure

11.1 Identify the sample location from sample location staking provided by FWS (land-based locations) or GPS coordinates (off-shore locations).

11.2 Prior to sampling, photo document the sampling location and surrounding area using a digital camera of 5 megapixels or better. Photographs need to include two or more reference points to facilitate relocating the sample location at a later date. On the Field Sampling Data Sheet, record the date and time of photographs, shot orientation, description of the shot, and the camera operator.

At the end of each day, images should be uploaded to a computer and the electronic files named. Each electronic file will include the location identifier, orientation of the shot, and subject description as a part of the file's properties. Record the photo ID electronic files names on the Field Sampling Data Sheet. The named photo files should then be electronically backed up on an external hard drive, CD, or other mass storage device. Quality control should be performed daily to ensure the images are clear and show the intended features.

Some general photographs should also be taken to document sampling collection methodology and activities during the field effort.

11.3 If called for in the Phase II Addendum to the RI/FS Work Plan and water is present, collect surface water samples and ancillary water chemistry data (see SOP 0025-003).

11.4 If no surface water samples are being collected at the location but water is present, collect ancillary water chemistry data (SOPs 0025-004, 0025-005, and 0025-006) and record the results on the Field Sampling Data Sheet. When wading, this should be done in a nearby undisturbed area. When sampling from a boat, this should be done at the deepest point along the transect.

11.5 Assemble the coring device, and make the necessary preparations to collect samples from the marked sample stations. Sediment samples will be collected with a coring device whenever possible.

11.5.1 The sediment sampling strategy for ponds, streams and the near-shore area of lakes (≤3 feet water depth) will consist of targeting the top 6 inches of sediments at each location as the top 6 inches represents the zone most likely to contain biological receptors. Samples will be collected at the 0-6 inch depth unless there is not sufficient sample volume for the sample. When the depositional layer is less than 6 inches thick, multiple samples will be collected in close proximity to obtain sufficient sample mass for chemical analysis. Features that determine if sediments are present include: evidence of frequently or permanently saturated conditions, crayfish chimneys, wetland vegetation, flattened (not curled) leaves, standing water, and vernal ponds.

11.5.2 The sediment sampling strategy for off-shore, quiescent areas of Crab Orchard Lake will consist of targeting the top 16 inches (40 cm) of sediments. The deeper sediments in the lake may provide information regarding historical deposition in the lake. Four sequential sediment samples will be collected from each core: 0 to 4 inches; 4 to 8 inches; 8 to 12 inches and 12 to 16 inches. Any material from the 16 to 20 inch interval will not be collected for analysis.

11.6 When sampling from a boat or barge, preparations to secure the boat with anchors must be made. A davit or tripod structure with the necessary winch and pulleys should be used to raise and lower the K-B corer (or equivalent). It is heavy, awkward to grasp, and relatively sensitive to jostling. It cannot be operated with a hand-over-hand technique along the cable. These arrangements will be specific to the actual boat, barge or other watercraft used, and cannot be prescribed in this SOP.

If an ephemeral water body is being sampled and no water is present, make the necessary preparations to collect samples with a trowel. Because no water is present, no ancillary field measurements will be collected. Insert the trowel into the sediment approximately 6 inches and place material into homogenizing vessel. Continue sampling and adding material to the homogenizing vessel into an appropriate amount is collected. Continue to Section 11.13.

11.7 Collect sediment samples with the core sampler. Press the Wildco core barrel (or equivalent) into the sediment with a constant pressure. If the sediment is firm, the sampler may be twisted in a clockwise manner to increase penetration. Retrieve the core sampler (lift vertically) when the core barrel has been inserted its full length into the sediment (or can't be inserted further as described in Sections 4.5 and 10.2). When using a K-B corer (or equivalent), lower the corer with the aid of a winch. Once the corer has ceased to descend, the messenger is clipped to the cable and released. When the messenger closes the check valve there will be an audible click, and the corer can be retrieved using the winch.

11.8 Remove the sediment sample from the core barrel. Have one person stand and hold the device vertically while a second person unscrews the nose piece, then carefully lift the core barrel off the core liner (which now contains the sediment sample). Carefully place end caps over both ends of the core liner. (The end caps may force air into the sediment core and disturb the sample; the end caps can be slit (see Section 9.3) to allow the air to escape). Set the core sample (in a vertical position) aside for extrusion. Rinse the core barrel with site water and reassemble with a new liner (and retainer), and continue sampling.

11.9 Decontaminate sampling equipment, including the spatula, the core barrel, and nose piece.

11.10 Extrude the sediment core(s) from the liner tube(s).

11.11 One person retrieves a core from a core-holding bucket and removes the top cap. Cut a slit along the side of the bottom cap to allow for easier removal but make sure that the bottom cap is still secure.

11.12 Carefully remove the bottom cap from the core liner, then remove the retainer.

11.13 Immediately insert the extruder into the bottom of the core liner to prevent the sediment sample from escaping. Push the extruder up into the core barrel (1/2 cm at a time) and scrape the extruded sediment sample into the compositing vessel. This process is repeated for each sampling point that is sampled per sampling location, and the extruded sediment for each sampling point is added to the compositing vessel. For

the off-shore cores in Crab Orchard Lake, the material from each layer is composited separately from the other layers.

11.14 Collect samples for volatiles prior to sample homogenization. Sample containers for volatiles should be filled completely. Air bubbles are not desirable because they could facilitate loss of compounds from the media of concern and bias sample results. Homogenize the remaining composited sediment in the compositing vessel. Fill the appropriate sample bottles, and store on ice.

11.15 Decontaminate the equipment to be re-used. For metals analyses, the plastic core liners, trowels and eggshells are inexpensive, and can be discarded. Stainless steel equipment is much more expensive, however, it is also very durable and easy to decontaminate.

11.16 Confirm that all field observations and information are recorded on the Field Sampling Data Sheet and Field Logbook. Entries into the Field Logbook should include the same information as the Field Data Sheet, but in an abbreviated style.

11.17 Prior to leaving land-based sample locations, ensure that the stake marking the sample location has a clearly legible identifier and is securely in the ground so that it can be accurately surveyed. For off-shore locations, record GPS coordinates.

12 Calculations (Not Applicable)

Applicable Forms

Field Logbook

Audit Checklist for Sediment Sampling

Audit Finding Report

Maintenance Log

Field Sampling Data Sheet

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1000 Hart Road, Suite 130
Barrington, Illinois 60010

Audit Checklist for Sediment Sampling

Project Description	Field Team Leader
Project No.	Audit Date
Sampling personnel	Audit No.

Audit Question	S	U	N/A	Comments
Were all personnel briefed on their assignment?	❑	❑	❑	
Did the crew have all the forms and maps, equipment and materials necessary to complete the assigned tasks?	❑	❑	❑	
Were the sampling locations correctly identified on the forms?	❑	❑	❑	
Were the field meters properly calibrated?	❑	❑	❑	
Were samples collected according to the procedure and all potential interferences addressed before sampling?	❑	❑	❑	
Was the depth of the sediment samples consistent?	❑	❑	❑	
Were sample locations properly marked for the survey crew?	❑	❑	❑	
Were the sampling equipment and meter probes properly cleaned between sample locations?	❑	❑	❑	
Were all sample containers properly labeled?	❑	❑	❑	
Were all sample containers properly filled (e.g. no head space)?	❑	❑	❑	
Were all samples properly packed for shipping?	❑	❑	❑	
packed in ice?	❑	❑	❑	
custody seals in appropriate places?	❑	❑	❑	
Did personnel adhere to the safety procedures?	❑	❑	❑	

Auditor Signature: _____

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Barrington, Illinois 60010

Audit Finding Report

Project No.	Task No.	Audit No.	Audit Date
Individual(s) contacted		Auditor Signature	
Requirements			
Findings			
Recommended Corrective Action			
Scheduled Response Date	Responsible for Corrective Action		
Corrective Action Taken			
Date	*Submitted by*	*Management Approval*	
Date Response Received		Response Acceptable? Yes No	
Reason for Rejection			
Verification			
Date Verified	Auditor Signature		

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Barrington, Illinois 60010

Maintenance Log

Manufacturer:			In-Service Date:
Model No:			Replacement Date:
S/N:			
Contact Information:			
Location:			
Date	Service Type	Serviced by:	Notes:

FIELD SAMPLING DATA SHEET

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Matrix: Sediment

Sample ID _____ PROJECT NO: 7163101 WBS#

AUS Area _____ Grab Composite DUP ☐ MS/MSD ☐ EB ☐

Equipment Used: Core Sampler Retainer Extruder Nose Piece Core Liners w/end caps

METERS: YSI DO/Ph/ORD/Conductivity/Temperature

SAMPLING PERSONNEL_____ FIELD TEAM LEADER_____

# of Containers _____ Sample Depth_____

SAMPLE DATE/TIME:_____/_____ (dd-mon-yy/military)

Field Description

Observations:_____

_____

_____

Sunny ☐ Partly Sunny ☐ Cloudy ☐ Raining ☐

Calm ☐ Slightly Windy ☐ Windy ☐ Gusting Winds ☐

Ambient Air Temperature: (C)_____

Samples Collected (check) Total Metals ☐ Dissolved Metals ☐ Explosives ☐ SVOCs ☐

Pesticides ☐ TSS ☐ Perchlorate ☐ TDS ☐

Sulfate ☐ PAH ☐ Pesticides ☐ Dioxin ☐

Surface Water Data: Specific conductance (µmhos)_____ Water Temperature (C) _____

pH_____ Dissolved oxygen (mg/L)_____ ORP _____(mV) + or –

Photo Date/Time:_____/_____ Camera Operator:_____

Camera ID:_____

Frame	Direction (facing)	Description	Photo ID File Name
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

COMMENTS:_____

_____

_____

_____

FWS Addendum to ENTRIX SOP #0025 003
29 April 2010 (modified by TRC June 2014)

This addendum summarizes modifications to ENTRIX SOP #0025 003 *Standard Operating Procedure for Collecting Surface Water Samples* which shall be incorporated into procedures for water sampling to support the Work Plan for an Engineering Evaluation/Cost Analysis (EE/CA) for the Pesticide Contamination at Area 7 Pesticide Area, Additional and Uncharacterized Sites Operable Unit.

Section 1 (2nd paragraph, replace last sentence) – *A peristaltic pump may only be used for the collection of surface water samples for analysis of pesticides when direct immersion of the sample containers cannot be performed at the specified sample depths.*

Section 4.6 (2nd and 3rd sentences) - If the sample container cannot be completely submerged into the water body, the sampling team should use a peristaltic pump with single-use tubing to collect the sample as to not disturb the underlying sediment. *If a peristaltic pump is to be used to collect samples for pesticide analysis, only polytetrafluoroethylene (PTFE), PTFE-lined polyethylene, and silicon tubing may be used. All tubing must be new, and a vacuum transfer container (glass and/or PTFE) should be placed between the pump intake and the pump head when collecting the sample. For pesticide sampling in shallow water, the preferred method is to use a clean 4 oz glass sampling jar to carefully collect water and transfer it into the amber bottle.*

Section 5 (replace 3rd sentence) – *Sample containers will be filled for each analyte group as specified in Tables 1 and 3 of the FSP.*

Section 5 – Delete table.

Section 6 (4th bullet) – HDPE and silicone tubing *(inorganic and field analyses only)*

Section 6 (add to bullet list) – PTFE-lined polyethylene tubing, vacuum transfer container, and silicon tubing (pesticide analysis only) (Section 4.6)

Section 11.1 (1st sentence) – Identify the sample location from sample location staking, *or GPS coordinates in open water,* provided by FWS.

Section 11.6 (1st sentence) - Collect water samples. Stream and puddle samples *where the water depth is less than 1 foot* should be collected at the *midpoint of the water column*. Off-shore (deeper pond and lake) samples should be collected within 15 cm *(or 6-inches)* of the sediment surface.

Section 11.6.1 (1st sentence) – *In shallow water and* for water sample vessels that do not contain preservatives, submerge the vessels to collect water samples.

Section 11.6.1 (4th and 5th sentences) – *The jar sampling method (see Section 4.6) is the preferred sampling method, especially for organic analytes (e.g., SVOCs, pesticides, and PAHs), however,* if the sample container cannot be completely submerged into the water body *at the specified sample depth,* the sampling team should use a peristaltic pump with single-use tubing to collect the sample as to not disturb the underlying sediment (see Section 11.6.2). *If used to collect samples for pesticide analysis, only PTFE, PTFE-lined polyethylene, silicon tubing, and a glass and/or PTFE vacuum transfer container for sample collection may be used (see Section 4.6).*

FWS Addendum to ENTRIX SOP #0025 003
29 April 2010 (modified by TRC June 2014)

Section 11.6.2 (1st paragraph, 3rd sentence) - *Samples for SVOC, PAH, and pesticides may be collected with a peristaltic pump, but only with the use of PTFE-lined polyethylene tubing, silicon tubing, and a glass and/or PTFE vacuum transfer container for sample collection. Also, care should be taken to minimize the length of the tubing used, especially the length of silicon passing through the pump head*.

Section 11.6.2 (2nd paragraph, replace) – Place the inlet end of the sample tubing into the correct sampling position in the water body (within 6-inches of the sediment surface, or at the midpoint of the water column where there is less than 1-foot of water). *Be sure to cut the tubing at the minimum length necessary to collect the water sample at the desired depth.* Take care not to contact or disturb the sediment. Turn on the pump and adjust the pump speed to ensure steady flow. The pump will operate in either direction, so check the inlet – if bubbles are forming, reverse the flow direction on the pump. Pump *at least two tubing-volumes of* water through the tubing assembly *prior to sample collection. Carefully detach the tubing on the inlet side of the pump. Make sure tubing is securely attached to the boat or other stable surface. Connect the vacuum transfer container to the pump tubing between the pump inlet and the pump head. Turn the pump on. Water should begin to collect in the transfer container. If water does not begin to flow, check the fittings and make sure the assembly is sealed. When the transfer container is nearly full, turn off pump, remove the transfer cap assembly and pour the sample into the appropriate containers.* Collect unfiltered samples first. Fill the bottles to the top, but do not overfill. Replace the caps and place the bottles on ice in a cooler.

Section 11.7 (last sentence) - For ancillary field measurement procedures, see *SOP-07*.

Section 11.12 (3rd sentence) - The GPS coordinates *for land based sample locations* are not adequate for use as final survey coordinates, the sampling stakes will need to be surveyed by *a* registered surveyor.

Section 11.13 (1st sentence) - If not shipping the same day, refrigerate samples overnight or maintain on ice in a cooler (in the locked job trailer*, or other secure, locked location*) in preparation for shipping to the laboratory. *Ensure that sample custody is maintained at all times (SOP-09).*

Section 11.13 (3rd sentence) - Place a tamper-evident custody seal on the refrigerator *(or sample cooler)* and check it before removing the samples for shipping the next day.

Section 11.14 – Verify sample identifications on the Chain-of-Custody (CoC) form. Sign the CoC form and fax or email copies of the field data sheets and the CoC to the Project Manager.

Standard Operating Procedure for Collecting Surface Water Samples

1 Scope & Summary

This protocol outlines techniques for collecting surface water from shallow, freshwater streams, ponds and drainage pathways for chemical analyses. This method is described for deployment by personnel that are wading, but the techniques may also be applied from a small, stable boat.

Water samples are collected by immersing sample bottles below the water surface and/or with a peristaltic pump. Samples for dissolved analysis are filtered by inserting a 0.45 µm in-line filter cartridge into the peristaltic pump assembly. Samples are placed into clean, labeled jars with minimum head space and packed in ice (in coolers) during transportation to the laboratory. Peristaltic pump is not used to collect samples for analyses of volatile organic compounds (VOCs), Semivolatile organic compounds (SVOCs) or polycyclic aromatic hydrocarbons (PAHs).

2 Reference Documents

USEPA (1982) *Handbook for sampling and sample preservation of water and wastewater.* EPA-600/4-82-029. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati OH, 402 pp.

3 Significance and Use

The samples collected by these methods are suitable for chemical characterization, but may be inadequate for biological analyses such as benthos and/or plankton characterization.

4 Potential Interferences

4.1 When sampling sediments in conjunction with surface water sampling, the surface (overlying) water samples must be collected before the sediment samples. The sediment surface will most likely be disturbed during sediment sample collection. This disturbance will increase the turbidity of the overlying water and might cause errors in the analytical chemistry data.

4.2 The presence of head space (bubbles) in sample containers for volatile and semi-volatile compounds might cause errors in the analytical chemistry data. Extra care must be taken to completely fill these sample containers. Full sample containers should be inverted to check for bubbles.

4.3 When possible, all water samples should be collected upstream of the sampling team when the sampling team must enter the water by foot or by boat to collect the sample. Disturbance of the sediments by the sampling team could potentially generate a surface water sample that is not representative of the sampling location and yield unreliable data.

4.4 The collection of ancillary field measurements (pH, dissolved oxygen, temperature, and specific conductance) should occur after the collection of surface water. Also, ancillary measurements should be collected at a nearby (i.e. within 5 feet) undisturbed area, typically upstream of the surface water sampling location. The collection of ancillary field measurements could potentially disturb the sediment in the vicinity of the surface water sampling location and cause errors in the analytical chemistry data.

4.5 The sampling team will don the proper sterile sampling gloves so that the sampling container and/or sample will not come into contact with the skin of the sampler.

Utilizing this procedure in the field minimizes the chances of the sample becoming contaminated by the sampler and yield unreliable data. Additionally, the wearing of sterile gloves provides a layer of protection to the sampler from potential dermal hazards while sampling.

4.6 If the water body to be sampled is shallow, the sampling team should avoid disturbing the sediments with the sample container. If the sample container cannot be completely submerged into the water body, the sampling team should use a peristaltic pump with single-use tubing (except for VOCs, SVOCs and PAHs) to collect the sample as to not disturb the underlying sediment. For the SVOC and PAH samples in shallow water, a clean 4 oz glass sampling jar should be used to carefully collect water and transfer it into the amber flasks.

4.7 When sampling with containers that have preservative, the sampling containers will not be submerged in the water. This is important so as to not lose the preservative within the sampling container. A peristaltic pump with single-use high-density polyethylene (HDPE) and silicone tubing will be used to collect the sample water for all analyses except VOCs, SVOCs and PAHs.

5 Apparatus

All surface water samples will be collected directly into the sample container by immersing the sample container below the water surface or by using a peristaltic pump with single-use tubing. Sample container type will be determined by the chemical analysis to be performed on the sample. The following table describes the sample containers for each analytical procedure.

Analytical Procedure	Sample Container
SVOCs (SW846/8270C)	Two 1-liter amber jar unpreserved
Metals (SW-846/6000-7000 Series)	One 500 ml plastic container with preservative
PAHs (SW-846/8310)	Two 1-liter amber jar unpreserved
Pesticides (SW-846/8081)	Two 1-liter amber jar unpreserved
OP Pesticides (SW-846/8141)	Two 1-liter amber jar unpreserved
Explosives (SW-846/8331)	Two 1-liter amber jar unpreserved
Perchlorate (SW-846/8321)	One 250 ml plastic container unpreserved
Total Suspended Solids (EPA/160.2)	One 250 ml plastic container unpreserved

It is important to reiterate that the sampling containers with preservative will not be submerged into the water for sampling. An appropriate separate non-preserved container will be filled with sample water or a peristaltic pump will be used to transfer the sample water to the sampling container with preservative.

6 Materials

- sample containers with lids;
- sample labels;
- peristaltic pump;
- HDPE and silicone tubing;
- 45 µm filter cartridges;
- pH meter;
- specific conductance meter;
- dissolved oxygen meter;
- temperature meter;
- Redox (ORP) meter

- waterproof marking pens;
- coolers (with ice) for sample storage;
- field data sheets & clip board;
- digital camera and electronic storage devices;
- personal & safety gear; and
- decontamination supplies.

7 Hazards & Precautions

7.1 Field-collected surface water might contain potentially toxic/hazardous materials, and thus should be treated with caution to minimize exposure to workers. Waterproof clothing (waders/heavy rubber boots) and gloves are recommended.

7.2 The sample container for metals analyses contains acid as a preservative, which might be harmful to sampling personnel. Extra care must be taken to prevent worker exposure to these preservatives and loss of the preservatives during sample collection.

7.3 The applicable Health and Safety information for the site must be reviewed to identify further hazards, precautions and safety procedures.

7.4 Wet sampling supplies become slippery and can easily be dropped. It is recommended that at least one spare bottle for each analysis type, as well as extra tubing and a filter are kept with a sample team at all times as ready replacements for equipment that could potentially become contaminated during sampling.

8 Sample Preparation

8.1 Sample locations may be adjusted on-site as deemed necessary by the location of riffles, pools, swallow areas, areas of low to no water, or other factors. A pre-sampling site inspection should be conducted to evaluate whether these procedures are feasible for sampling the desired locations.

8.2 Appropriate new sample containers must be obtained from the analytical laboratory or a commercial supplier. The analytical procedures must be reviewed to identify the proper sample container material, size, and preparation.

8.3 The Field Team Leader must read the Quality Assurance Project Plan before field sampling procedures are undertaken to understand how many, and what type of QA/QC samples are required.

8.4 All field team personnel must read the Health and Safety Plan prior to sampling to review applicable safety requirements.

9 Preparation of Apparatus

9.1 All sampling containers will be pre-cleaned and delivered to the sampler without threat of contamination. During surface water sampling, if the sample container comes into contact with any surface other than the sample water or the samplers gloved hand, the sampler will discard the potentially contaminated container and use another pre-cleaned container to retrieve the sample.

9.2 The sampling containers and filter cartridges will arrive in sealed boxes that contain certificates of analysis.

9.3 The field meters and probes should be tested and calibrated daily (see Section 10). The dissolved oxygen meter may take several minutes to equilibrate (or could lose calibration) if it is turned off; it should be left on for the entire sampling day.

10 Calibration & Standardization

The field meters (pH, dissolved oxygen, and specific conductance) must be calibrated according to the manufacturer's manuals on a daily basis. The results of the calibration should be recorded on the maintenance log for each instrument, and noted in the field logbook.

11 Procedure

11.1 Identify the sample location from sample location staking provided by FWS. If both surface water and sediment samples are to be collected from a given location, complete surface water sampling before sediment sampling.

11.2 Prior to sampling, photo document the sampling location and surrounding area using a digital camera of 5 megapixels or better. Photographs need to include two or more reference points to facilitate relocating the sample location at a later date. On the Field Sampling Data Sheet, record the date and time of photographs, shot orientation, description of the shot, and the camera operator.

At the end of each day, images should be uploaded to a computer and the electronic files named. Each electronic file will include the location identifier, orientation of the shot, and subject description as a part of the file's properties. Record the photo ID electronic files names on the Field Sampling Data Sheet. The named photo files should then be electronically backed up on an external hard drive, CD, or other mass storage device. Quality control should be performed daily to ensure the images are clear and show the intended features.

Some general photographs should also be taken to document sampling collection methodology and activities during the field effort.

11.3 Label all sample bottles for the specific sample location.

11.4 Complete the field data sheet with the information for the time, date and observations.

11.5 Don clean gloves and prepare to collect water samples.

11.6 Collect water samples. Stream and puddle samples should be collected at the water surface. Off-shore (deeper pond and lake) samples should be collected within 15 cm of the sediment surface.

11.6.1 For water sample vessels that do not contain preservatives, submerge the vessels to collect water samples. Be certain to avoid turbidity caused by disturbance of the sediment surface; completely fill (no bubbles) the sample containers for SVOC analyses. If the water body to be sampled is shallow, the sampling team should avoid disturbing the sediments with the sample container. If the sample container cannot be completely submerged into the water body, the sampling team should use a peristaltic pump (except for VOC, SVOC and PAH samples) with single-use tubing to collect the sample as to not disturb the underlying sediment (see Section 11.6.2). For SVOC, VOC and PAH samples in shallow water, a 4 oz glass jar should be used to carefully collect water and transfer it to the amber jars. At off-shore sample locations, the end of the tubing should be weighted so the water intake point is near (15 cm or less) the sediment-water interface. The cartridge filter will provide sufficient mass to submerge the tubing when attached. For non-filtered samples, a decontaminated weight should be attached to the tube with a decontaminated white cable tie. Use vinyl tape or a cable tie to mark the appropriate depth on the HDPE tubing so the cartridge filter does not contact the sediments when it is attached.

11.6.2 If water body is too shallow to submerge sample containers and/or water sample containers with preservatives are to be collected, assemble the peristaltic pump with the single-use tubing. Samples for VOC analysis (which contain preservatives) should

not be collected with the peristaltic pump. Samples for SVOC and PAH analyses also should not be collected with the peristaltic pump to avoid potential analyte adsorption into the silicone tubing or leaching. Place the pump on a stable surface that is easy to reach from the sampling location. Replace gloves if they become soiled.

Pump water through the tubing assembly for a few seconds to purge the tubing. Collect all unfiltered samples first by inserting the inlet end of the tube into the water body, taking care to not contact or disturb the sediments. Turn on the pump and adjust the pump speed to ensure a steady flow. The pump will operate in either direction, so check the inlet; if bubbles are forming, reverse the flow direction on the pump. Fill the sample bottles to the top but do not overfill. Replace the caps and place the bottles on ice in a cooler.

For samples being submitted for dissolved metals analysis install an unused disposable 0.45 µm filter cartridge onto one end of the tubing. Filters must be pre-rinsed following the manufacturer's instructions; when the manufacturer does not provide pre-rinsing recommendations, pass a sufficient volume of surface water through the filter to completely wet the filter prior to collecting the water sample. If the water is deep enough that the filter will not contact the sediments, place the filter on the inlet end so the weight of the filter will stabilize the tubing. Placing the filter on the inlet tube will also minimize back pressure on the filter-tube connection for turbid waters. If the water is shallow, place the filter on the outlet end and monitor the pump speed so that pressure within the tubing does not separate the filter from the assembly.

- Make sure the arrow on the filter is pointing in the correct direction and the filter is leakproof. Turn on the pump to apply pressure to the tubing and filter system. Hold the filter cartridge so the flow (arrow) is vertically upward while it initially fills with water. Tap the side of the cartridge while it initially fills with water several times to force air out of the filter. Purging air prevents oxidation and possible precipitation of redox-sensitive analytes such as iron, manganese, and aluminum that could introduce a low bias into the analytical data.
- After the filter cartridge has been purged of air, collect the water samples in the appropriate clean (unused), laboratory-certified bottles. Monitor the speed of flow to prevent leaks. If the filter clogs it will create back pressure, leak and then separate from the tubing. Do not attempt to increase flow speed or force water through the filter because it could become compromised and allow particles to pass. If the filter becomes clogged, turn off the pump to relieve pressure, disconnect the filter and replace it with a new cartridge. Monitor the cartridge performance carefully when turbid water is sampled, and when large volumes of water are collected, such as MS/MSD volumes or field duplicate samples, and replace the cartridge when the water delivery rate becomes slow or there is sufficient pressure to result in a leak. Purge the new cartridge as described above and resume sample collection. When sampling is completed, release pressure on the sample train by reversing the pump flow and discard the filter and tubing in accordance with the approved Work Plan.

11.7 Collect ancillary field measurements (pH, redox, temperature, specific conductance) in an area immediately upstream of, or slightly away from the sampling site if the sampling location was disturbed. For ancillary field measurement procedures, see SOPs 0025-004, 0025-005, and 0025-006.

11.8 Recheck the field data sheet against the sample bottles before leaving the sampling location.

11.9 Pack the water samples in the cooler with ice.

11.10 Decontaminate the pH, redox, temperature, specific conductance, and dissolved oxygen meter probes.

11.11 Confirm that all field observations and information are recorded on the Field Sampling Data Sheet and Filed Logbook. Entries into the Field Logbook should include the same information as the Field Data Sheet, plus additional specific information that will allow the sampling day to be reconstructed.

11.12 Prior to leaving land-based sample locations, ensure that the stake marking the sample location has a clearly legible identifier and is securely in the ground so that it can be accurately surveyed. For off-shore locations, record GPS coordinates. The GPS coordinates are not adequate for use as final survey coordinates, the sampling stakes will need to be surveyed by the registered surveyor, through Shannon & Wilson.

11.13 If not shipping the same day, refrigerate samples overnight (in the locked and fenced job trailer) in preparation for shipping to the laboratory. Do not put food in sample refrigerator; do not put samples in the food refrigerator. Place a tamper-evident custody seal on the refrigerator and check it before removing the samples for shipping the next day.

11.14 Verify sample identifications on the Chain-of-Custody (CoC) form. Sign the CoC form and fax or email copies of the field data sheets and the CoC to the ENTRIX Project manager.

11.15 Ship the samples to the analytical laboratory.

12 Calculations (Not Applicable)

Applicable Forms

Field Sampling Data Sheet	Maintenance Log
Audit Checklist for Surface Water Sampling	Audit Finding Record

FIELD SAMPLING DATA SHEET

ENTRIX
ENVIRONMENTAL CONSULTANTS

Matrix: Surface Water

Sample ID _____ PROJECT NO: 7163101 WBS#

AUS Area _____ Grab Composite DUP ☐ MS/MSD ☐ EB ☐

Equipment Used: peristaltic pump HDPE tubing Silicone tubing filter cartridge
METERS: DO& temperature/pH/ORP/Conductivity

SAMPLING PERSONNEL_____ FIELD TEAM LEADER_____

# of Containers _____ Sample Depth_____

SAMPLE DATE/TIME:_____/_____ (dd-mon-yy/military)

Field Description
Observations:_____ _____

_____

_____

Sunny ☐ Partly Sunny ☐ Cloudy ☐ Raining ☐
Calm ☐ Slightly Windy ☐ Windy ☐ Gusting Winds ☐
Ambient Air Temperature: (C)_____

Samples Collected (check)

Total Metals	☐	Dissolved Metals	☐	Explosives	☐	SVOCs	☐
Pesticides	☐	TSS	☐	Perchlorate	☐	TDS	☐
Sulfate	☐	PAH	☐	Pesticides	☐	Dioxin	☐

Surface Water Data: Specific conductance (µmhos)_____ Water Temperature (C) _____

pH_____ Dissolved oxygen (mg/L)_____ ORP _____(mV) + or –

Photo Date/Time:_____/_____ Camera Operator:_____

Camera ID:_____

Frame	Direction (facing)	Description	Photo ID File Name
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

COMMENTS:_____

_____

_____

_____

_____

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1000 Hart Road, Suite 130
Barrington, Illinois 60010

Audit Checklist for Surface Water Sampling

Project Description	Field Team Leader
Project No.	Audit Date
Sampling personnel	Audit No.

Audit Question	S	U	N/A	comments
Were all personnel briefed on their assignment?	❑	❑	❑	
Did the crew have all the forms and maps, equipment and materials necessary to complete the assigned tasks?	❑	❑	❑	
Were the sampling locations correctly identified on the forms?	❑	❑	❑	
Were the field meters properly calibrated?	❑	❑	❑	
Were samples collected according to the procedure and all potential interferences addressed before sampling?	❑	❑	❑	
Was the depth of the sediment samples consistent?	❑	❑	❑	
Were sample locations properly marked for the survey crew?	❑	❑	❑	
Were the sampling equipment and meter probes properly cleaned between sample locations?	❑	❑	❑	
Were all sample containers properly labeled?	❑	❑	❑	
Were all sample containers properly filled (e.g. no head space)?	❑	❑	❑	
Were all samples properly packed for shipping?	❑	❑	❑	
packed in ice?	❑	❑	❑	
custody seals in appropriate places?	❑	❑	❑	
Did personnel adhere to the safety procedures?	❑	❑	❑	

Auditor Signature: _____

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Barrington, Illinois 60010

Audit Finding Report

Project No.	Task No.	Audit No.	Audit Date
Individual(s) contacted		Auditor Signature	
Requirements			
Findings			
Recommended Corrective Action			
Scheduled Response Date	Responsible for Corrective Action		
Corrective Action Taken			
Date	*Submitted by*	*Management Approval*	
Date Response Received		Response Acceptable? Yes No	
Reason for Rejection			
Verification			
Date Verified	Auditor Signature		

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Barrington, Illinois 60010

Maintenance Log

Manufacturer:	**In-Service Date:**
Model No:	**Replacement Date:**
S/N:	
Contact Information:	
Location:	

Date	Service Type	Serviced by:	Notes:

TRC Addendum to ECCS-01
28 June 2013

This addendum summarizes modifications to SOP ECCS-01 *PCB and Pesticide Wipe Analysis* which shall be incorporated into procedures for wipe sampling to support the Work Plan for an Engineering Evaluation/Cost Analysis (EE/CA) for the Pesticide Contamination at Area 7 Pesticide Area, Additional and Uncharacterized Sites Operable Unit.

Introduction – Delete last sentence ("Attachment A is guidance…").

Attachment A – Deleted.

PCB AND PESTICIDE WIPE ANALYSIS
Supplemental Sample Collection Guidance

Disclaimer: This document is not meant to replace 40CFR761 Subpart G – PCB Spill Cleanup Policy, or any other relevant Federal, state, or local requirements for collecting wipe samples. The guidance provided herein is for the sole purpose of communicating minimum requirements to collect a representative wipe sample for ultimate analysis by ECCS Method LAM-005 8082 PCBs or ECCS Method LAM-003 Organochlorine Pesticides. Attachment A is guidance from 40CFR relevant to PCB wipes and is provided herein for additional guidance on the subject topic.

1.0 Purpose

The purpose of this information is to provide guidance for the collection of wipe samples of solid surfaces potentially contaminated with polychlorinated biphenyl (PCB) and pesticide residues. Wipe samples are taken to determine the degree of surface contamination and provide information on environmental exposure.

2.0 Supplies Provided by Laboratory

2.1 3 inch by 3 inch sterile gauze pads

2.2 4 ounce amber sample jars

2.3 80/20 iso-octane/acetone or hexane

2.4 5 ¾ inch Pasteur pipettes and bulb

3.0 Collection of Wipe Sample

3.1 Select surface to be sampled. It should be a relatively flat and smooth surface that can be easily and thoroughly wiped with the gauze. A single sample will be of a 100 cm^2 area (10 cm x 10 cm). Identify the 100 cm^2 area(s) to be sampled in accordance with applicable regulations and guidance.

3.2 Put on a fresh clean pair of gloves for each wipe sample.

3.3 Prepare a gauze pad by moistening it with 80/20 iso-octane/acetone using a Pasteur pipette (do not soak).

3.4 Wipe the 100 cm^2 area in accordance with applicable regulations and guidance.

3.5 Be careful not to allow the gauze to touch any other surface, fold it over with the wipe surface to the inside and insert it into the sample jar in which the pad was shipped.

3.6 Repeat the above steps for additional samples.

Attachment A

EPA Guidance on PCB Wipe Sampling

Site Specific Standard Operating Procedure 004
Calibration of Field Instruments for Water Quality Parameters
Crab Orchard National Wildlife Refuge - AUSOU Area 7 Pesticide Area

1.0 Introduction

1.1 Scope & Applicability

The purpose of this standard operating procedure (SOP) is to provide a framework for calibrating field instruments used to measure water quality parameters for ground water and surface water. Water quality instruments addressed in this SOP include those that measure temperature, pH, dissolved oxygen (DO), conductivity/specific conductance, oxidation-reduction potential (ORP), and turbidity.

This SOP is written for instruments that utilize multiple probes for temperature, pH, DO, conductivity/specific conductance, ORP, and turbidity. This SOP refers to instrumentation and outlines calibration procedures consistent with those discussed in USEPA Region I Standard Operating Procedure, *Draft Calibration of Field Instruments*, dated June 3, 1998.

For ground water monitoring during well development and/or purging prior to sample collection, the multiple probe instrument must be equipped with a flow-through cell. Turbidity is measured using a separate instrument because turbidity cannot be measured accurately in a flow-through cell.

1.2 Summary of Method

All monitoring instruments must be calibrated before they are used to measure environmental samples.

Most instruments will require at least two standards to bracket the expected measurement range, one standard less than the expected value and one higher. At a minimum, calibration must be performed at the beginning of each sampling day prior to sample collection. Site-specific plans should be consulted for required calibration frequency. Note: Part of the instrument preparation and initial calibration is performed prior to the field event.

This SOP requires that the manufacturer's instruction manual (including the instrument specifications) accompany the instrument into the field.

1.3 Equipment

The following equipment should be used when calibrating water quality parameter measuring equipment. Site-specific conditions may warrant the use of additional items or deletion of items from this list.

- Appropriate level of personal protection
- Water quality meter capable of measuring pH, temperature, dissolved oxygen, specific conductance, and oxidation-reduction potential (e.g., YSI 556, or equivalent)
- Turbidity Meter (e.g., Hach 2100P, or equivalent)
- Distilled water
- Deionized water
- Flow-through cell
- Ring stand with clamp
- Paper towels
- Soft tissue (e.g., Kimwipes)
- Cuvette
- pH buffer solutions
- Conductivity solution
- Zobell solution
- Turbidity standards
- DO membrane kit (electrolyte solution, membranes)
- NIST thermometer (0.01°C accuracy)
- Small glass or polyethylene jars to hold the calibration standards (4-8 oz.)
- Calibration Logbook
- Field Instrument Calibration Logs
- Cup or spray bottle for the distilled water

1.4 Definitions

- SOP Standard Operating Procedure
- pH Potential of Hydrogen
- ORP Oxidation-Reduction Potential
- NIST National Institute of Standards and Technology

- C Celsius
- mg Milligram
- L Liter
- DO Dissolved Oxygen
- mm Millimeter
- NTU Nephelometric Turbidity Unit
- PPE Personal Protective Equipment
- Sonde Device that holds the measuring probes
- SU Standard Units
- µg Microgram

1.5 Health & Safety Warnings

TRC employees will be on site when implementing this SOP. Therefore, TRC personnel shall follow the site-specific Health & Safety Plan. TRC personnel will use the appropriate level of PPE, which may include the following: 1) hardhat; 2) safety boots (steel toe/steel shank); 3) safety glasses; and 4) chemical-resistant gloves.

Implementing this SOP will require the use of calibration solutions. The following health and safety precautions must be taken with the pH, conductivity, and ORP solutions: Avoid inhalation, skin and eye contact, and ingestion.

Maintenance of the instruments will require the use of liquid cleaners. Although these substances are not hazardous materials, TRC will appropriately handle and store them at all times in accordance with manufacturer's instructions.

1.6 Cautions & Potential Problems

- Prior to calibration, all instrument probes must be cleaned according to the manufacturer's instructions. Failure to perform this step (proper maintenance) can lead to erroneous measurements.
- Prior to using calibration standards, check all expiration dates.
- Use a ring stand and clamp to secure the sonde in an upright position. This will prevent the sonde from falling over and damaging the probes.
- The volume of the calibration solutions must be sufficient to cover both the probe being calibrated and the temperature sensor (see manufacturer's instructions for additional information).

- While calibrating or performing sample measurements, make sure there are no air bubbles lodged between the probe and the probe guard.
- DO content in water is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic and or erroneous measurements. If the probe reading shows the error message, "value out of range", the instrument probe must be recalibrated.

1.7 Personnel Qualifications

Since this SOP will be implemented at sites or in work areas that entail potential exposure to toxic chemicals or hazardous environments, all TRC personnel must be adequately trained. Before implementing this SOP alone, TRC personnel must be trained in these procedures by a senior staff member with experience operating the equipment. In addition, all personnel utilizing this SOP must have completed the following:

- 40-hour OSHA training
- 8-hour annual refresher training
- On-site training

In addition to the 40-hour initial OSHA training (and annual 8-hour refresher training), all TRC field staff will complete 24 hours of supervised field experience that contribute toward the 24-hour field supervised requirement in compliance with OSHA regulation: 29 CFR 1910.120(e)(4).

2.0 Procedures

The probe readings for pH, dissolved oxygen, and specific conductance are automatically corrected for temperature by the instrument. Communications to the instrument (programming and displaying the measurement files) are performed using a display/logger or a computer. Information sent to the instrument is entered through the keypad on the display/logger or computer. If the instrument does not have a keypad, follow the manufacturer's instructions for entering information into the instrument.

- Program the multi-probe instrument so that the following parameters to be measured will be displayed: temperature, pH, dissolved oxygen, specific conductance, and ORP. Refer to Attachment D for correct units.

For instrument probes that rely on the temperature sensor (pH, DO, specific conductance, and ORP), each temperature sensor needs to be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST). Before any instrument

is calibrated or used to perform environmental measurements, the instrument must stabilize (warm-up) according to manufacturer's instructions.

2.1 Temperature

Most instrument manuals state that calibration of the temperature sensor is not required, but this SOP requires that the temperature sensor be checked to verify its accuracy. This accuracy check is performed at least once per year and the accuracy check date/information is kept with the instrument. If the accuracy check date/information is not included with the instrument or the last check was performed over a year prior to the date of use, it is recommended that the temperature sensor accuracy be checked at the beginning of the sampling event. If the instrument contains multiple temperature sensors, each sensor must be checked.

Verification Procedure

1. Allow a container filled with water to equilibrate to ambient temperature.
2. Place a NIST-traceable thermometer and the instrument's temperature sensor into the water and wait approximately five minutes for both temperature readings to stabilize.
3. Compare the two measurements. The instrument's temperature sensor must agree with the NIST-traceable thermometer measurement within the accuracy of the sensor (usually $\pm$0.15°C). If the measurements do not agree, the instrument may not be working properly and the manufacturer needs to be consulted.

2.2 Dissolved Oxygen

DO is the volume of oxygen that is dissolved in water and is measured using a membrane electrode. The DO probe's membrane and electrolyte solution should be replaced prior to the sampling period. Failure to perform this step may lead to erratic or erroneous measurements.

Calibration Procedure

1. Gently dry the temperature sensor according to manufacturer's instructions.
2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container that comes with the instrument.
3. Place the DO probe in the container without the probe coming in contact with the wet sponge or paper towel. The probe must fit loosely in the container to ensure it is vented to the atmosphere.

4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn-on the instrument to allow the DO probe to warm-up. Select monitoring/run mode. Check temperature readings. Readings must stabilize before continuing to the next step.
5. Select calibration mode; then select "DO%".
6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument. This measurement can be determined from an on-site barometer. Do not use barometric pressure obtained from the local weather services unless the pressure is corrected for the elevation of the sampling location and unless this is the only source of barometric data. [**Note:** inches of mercury times 25.4 mm/inch mercury equals mm of mercury].
7. The instrument should indicate that the calibration is in progress. After calibration, the instrument should display percent saturated DO. Check the reading against the Temperature/Atmospheric Pressure table in Attachment A. For example, if the barometric pressure is 752 mm Hg at an elevation of 278 feet, the percent saturation value after calibration should be 99%.
8. While the probe is still in the calibration cup, select monitoring/run mode. Compare the DO mg/L reading to the Oxygen Solubility at Indicated Pressure chart in Attachment B. For example, if the barometric pressure is 750 mm Hg and the temperature inside the calibration cup is 20°C, the DO mg/L reading should be 8.94 mg/L. If they do not agree to the accuracy of the instrument (usually $\pm$ 0.2 mg/L), repeat calibration. If this does not work, change the membrane and electrolyte solution and repeat calibration.

2.3 pH (electrometric)

The pH is the measure of the degree of the acidity or alkalinity of a solution as measured on a scale of 0 to 14. The pH of a sample is determined electrometrically using a glass electrode. All pH measurements are in standard units (SU).

Choose the appropriate buffered standards that will bracket the expected values at the sampling locations. For ground water, the pH will usually be close to seven. Three standards are needed for the calibration: one close to seven, one at least two pH units below seven and the other at least two pH units above seven. For those instruments that will not accept three standards, the instrument will need to be re-calibrated if the water sample's pH is outside the range defined by the two standards used in the initial calibration.

Calibration Procedure

1. Allow the buffered standards to equilibrate to the ambient temperature.

2. Fill calibration containers with the buffered standards so each standard will cover the pH probe and temperature sensor.
3. Remove the cover of the probe, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue.
4. Select monitoring/run mode. Immerse probe in the initial buffered standard (e.g., pH 7) and allow at least 1 minute for temperature equilibration before proceeding.
5. Enter the buffered standard value (7) into the pH calibration menu of the instrument. Allow the pH reading to stabilize for approximately 30 seconds and if the reading does not change, finish the calibration. The reading should remain within the manufacturer's specifications; if it changes, recalibrate. If readings continue to fluctuate or readings do not stabilize after recalibration, consult the manufacturer.
6. Remove probe from the initial buffered standard, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue.
7. Immerse probe into the second buffered standard (e.g., pH 4). Repeat step 5, substituting "4" into the pH calibration menu instead of "7".
8. Remove probe from the second buffered standard, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue. If the instrument only accepts two standards the calibration is complete. Proceed to step 11. Otherwise continue with step 9.
9. Immerse probe in third buffered standard (e.g., pH 10). Repeat step 5, substituting "10" into the pH calibration menu instead of "7".
10. Remove probe from the third buffered standard, rinse in a cup filled with distilled water or use a spray bottle, and blot dry with soft tissue.
11. Select monitoring/run mode, if not already selected. To ensure that the initial buffered calibration standard (e.g., pH 7) has not changed, immerse the probe into the initial standard. Wait for the reading to stabilize. The reading should read the initial standard value (e.g., 7) within the manufacturer's specifications. If not, re-calibrate the instrument. If re-calibration does not help, the calibration range may be too great. Reduce calibration range by using standards that are closer together.

2.4 Specific Conductance

Conductivity is used to measure the ability of an aqueous solution to conduct an electrical current. Specific conductance is the conductivity value corrected to 25°C. Calibrating an instrument for specific conductance automatically calibrates the instrument for conductivity, and vice-versa.

Most instruments are calibrated against a single standard which is near, but below the specific conductance of the environmental samples. A second standard which is above the environmental sample specific conductance may be used to check the linearity of the instrument in the range of measurements.

Calibration Procedure

1. Allow the calibration standard to equilibrate to the ambient temperature.
2. Remove probe from its storage container, rinse the probe with a small amount of the conductivity/specific conductance standard (discard the rinsate), and place the probe into the conductivity/specific conductance standard. Gently move the probe up and down in the solution to remove any air bubbles from the sensor. Allow the probe to sit in the solution for at least 1 minute for temperature equilibration before proceeding.
3. Select calibration mode.
4. Select Specific Conductance from the Calibration menu. Enter the calibration value of the solution (mS/cm at 25°C) and continue. Allow the Specific Conductance reading to stabilize for approximately 30 seconds and finish the calibration. The reading should remain within manufacturer's specifications. If it does not, recalibrate. If readings continue to change after recalibration, consult the manufacturer.

NOTE: These procedures should only be used for instruments that are capable of automatically correcting specific conductance for temperature (to 25°C). For instruments that cannot calibrate for specific conductance, follow the procedures in the instrument's manual for conductivity calibration. If calibrating for conductivity instead of specific conductance, the solutions conductivity value must be corrected for the temperature that the sensor is reading.

2.5 Oxidation-Reduction Potential (ORP)

The oxidation-reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent.

Calibration or Verification Procedure

1. Allow the calibration standard (a Zobell Solution) to equilibrate to ambient temperature.
2. Remove the cover of the probe and place it into the standard.

3. Select monitoring/run mode.
4. While stirring the standard, wait for the probe temperature to stabilize, and then read the temperature.
5. Look up the millivolt (mV) value at this temperature from the millivolt versus temperature correction table found in Attachment C. It may be necessary to interpolate millivolt values between temperatures. Select "calibration mode", then "ORP". Enter the temperature-corrected ORP value and calibrate the instrument.
6. Select monitoring/run mode. The reading should remain unchanged within manufacturer's specifications. If it changes, re-calibrate. If readings continue to change after calibration, consult manufacturer.
7. If the instrument instruction manual states the instrument is factory calibrated, then verify the factory calibration against the standard. If reading does not agree within the specification of the instrument, the instrument will need to be re-calibrated by the manufacturer.

2.6 Turbidity

Turbidity refers to how clear the water is and is a measure of relative sample clarity. The greater the amount of total suspended solids in the water, the higher the measured turbidity. The turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidity meter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source.

Some instruments will only accept one standard. For these instruments, the standards will serve as check points.

Calibration Procedures

1. If the standard cuvette is not sealed, rinse a cuvette with deionized water. Shake the cuvette to remove as much water as possible. Do not wipe the inside of the cuvette because lint from the wipe may remain in the cuvette. Add the standard to the cuvette.
2. Before performing the calibration procedure, make sure the cuvettes are not scratched and the outside surfaces are dry, free from fingerprints and dust. If the cuvette is scratched or dirty, discard or clean the cuvette, respectively.

3. Zero the instrument by using either a zero or 0.02 NTU standard. A zero standard (approximately 0 NTU) can be prepared by passing distilled water through a 0.45 micron pore size membrane filter.
4. Using a standard at 1 to 10 NTU, calibrate according to manufacturer's instructions or verify calibration if instrument will not accept a second standard. If verifying, the instrument should read the standard value to within the specifications of the instrument. If the instrument has a range of scales, check each range that will be used during the sampling event with a standard that falls within that range.
5. Using a standard at 10 to 100 NTU, calibrate according to manufacturer's instruction or verify calibration if instrument does not accept a third standard. If verifying, the instrument should read the standard value to within the specifications of the instrument.

NOTE: If only performing a two-point calibration (depending on project requirements), the 0.02 NTU and 10 NTU standard should be used.

3.0 Data Management and Records Management

Prior to calibrating, the field equipment and calibration standard information should be recorded in a field logbook or separate Field Instrument Calibration Log. For field equipment, the information recorded should include the make, model number and the serial number of the instrument. Each instrument can be assigned an identification number which can be referenced in future field notes or when filling out the Field Instrument Calibration Log. For calibration standards, the information recorded should include the manufacturer, expiration date, true value, and any other description such as lot number. Each calibration standard can also be assigned an identification number which can be referenced in future field notes or when filling out the Field Instrument Calibration Log. All standards should be initialed and dated when opened.

All calibration measurements must be documented in a field logbook or separate Field Instrument Calibration Log. An example calibration log is presented in Attachment D. At a minimum, the log must include the instrument information described above, calibration standard information described above, calibration date, and the instrument calibration results.

4.0 REFERENCES

Standard Methods for the Examination of Water and Wastewater, 19th Edition, 1995.

USEPA Region I. *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples for Monitoring Wells*, July 30, 1996.

USEPA Region I. *Standard Operating Procedure, Draft Calibration of Field Instruments*, June 3, 1998.

Attachment A
Dissolved Oxygen Calibration Values for Various Atmospheric Pressures and Altitudes

Dissolved Oxygen Calibration Values for Various Atmospheric Pressures and Altitudes

PRESSURE			ALTITUDE		CALIBRATION VALUE
Inches Hg	mm Hg	Millibars	Feet	Meters	Percent Saturation
30.23	768	1023	-276	-84	101
29.92	760	1013	0	0	100
29.61	752	1003	278	85	99
29.33	745	993	558	170	98
29.02	737	983	841	256	97
28.74	730	973	1126	343	96
28.43	722	963	1413	431	95
28.11	714	952	1703	519	94
27.83	707	942	1995	608	93
27.52	699	932	2290	698	92
27.24	692	922	2587	789	91
26.93	684	912	2887	880	90
26.61	676	902	3190	972	89
26.34	669	892	3496	1066	88
26.02	661	882	3804	1160	87
25.75	654	871	4115	1254	86
25.43	646	861	4430	1350	85
25.12	638	851	4747	1447	84
24.84	631	841	5067	1544	83
24.53	623	831	5391	1643	82
24.25	616	821	5717	1743	81
23.94	608	811	6047	1843	80
23.62	600	800	6381	1945	79
23.35	593	790	6717	2047	78
23.03	585	780	7058	2151	77
22.76	578	770	7401	2256	76
22.44	570	760	7749	2362	75
22.13	562	750	8100	2469	74
21.85	555	740	8455	2577	73
21.54	547	730	8815	2687	72
21.26	540	719	9178	2797	71
20.94	532	709	9545	2909	70
20.63	524	699	9917	3023	69
20.35	517	689	10293	3137	68
20.04	509	679	10673	3253	67
19.76	502	669	11058	3371	66

Table taken from EPA Region I SOP, Draft Calibration of Field Instruments, June 3, 1998.

Attachment B
Oxygen Solubility at Indicated Pressure

Oxygen Solubility at Indicated Pressure
(Page 1 of 2)

Oxygen Solubility at Indicated Pressure

Temp.	Pressure (Hg)							
	760	755	750	745	740	735	730	mm
°C	29.92	29.72	29.53	29.33	29.13	28.94	28.74	in
0	14.57	14.47	14.38	14.28	14.18	14.09	13.99	mg/l
1	14.17	14.08	13.98	13.89	13.79	13.70	13.61	
2	13.79	13.70	13.61	13.52	13.42	13.33	13.24	
3	13.43	13.34	13.25	13.16	13.07	12-98	12.90	
4	13.08	12.99	12.91	12.82	12.73	12.65	12.56	
5	12.74	12.66	12.57	12.49	12.40	12.32	12.23	
6	12.42	12.34	12.26	12.17	12.09	12.01	11.93	
7	12.11	12.03	11.95	11.87	11.79	11.71	11.63	
8	11.81	11.73	11.65	11.57	11.50	11.42	11.34	
9	11.53	11.45	11.38	11.30	11.22	11.15	11.07	
10	11.28	11.19	11.11	11.04	10.96	10.89	10.81	
11	10.99	10.92	10.84	10.77	10.70	10.62	10.55	
12	10.74	10.67	10.60	10.53	10.45	10.38	10.31	
13	10.50	10.43	10.36	10.29	10.22	10.15	10.08	
14	10.27	10.20	10.13	10.06	10.00	9.93	9.86	
15	10.05	9.98	9.92	9.85	9.78	9.71	9.65	
16	9.83	9.76	9.70	9.63	9.57	9.50	9.43	
17	9.63	9.57	9.50	9.44	9.37	9.31	9.24	
18	9.43	9.37	9.30	9.24	9.18	9.11	9.05	
19	9.24	9.18	9.12	9.05	8.99	8.93	8.87	
20	9.06	9.00	8.94	8.88	8.82	8.75	8.69	
21	8.88	8.82	8.76	8.70	8.64	8.58	8.52	
22	8.71	8.65	8.59	8.53	8.47	8.42	8.36	
23	8.55	8.49	8.43	8.38	8.32	8.26	8.20	
24	8.39	8.33	8.28	8.22	8.16	8.11	8.05	
25	8.24	8.18	8.13	8.07	8.02	7.96	7.90	
26	8.09	8.03	7.98	7.92	7.87	7.81	7.76	
27	7.95	7.90	7.84	7.79	7.73	7.68	7.62	
28	7.81	7.76	7.70	7.65	7.60	7.54	7.49	
29	7.68	7.63	7.57	7.52	7.47	7.42	7.36	
30	7.55	7.50	7.45	7.39	7.34	7.29	7.24	
31	7.42	7.37	7.32	7.27	7.22	7.16	7.11	
32	7.30	7.25	7.20	7.15	7.10	7.05	7.00	
33	7.08	7.13	7.08	7.03	6.98	6.93	6.88	
34	7.07	7.02	6.97	6.92	6.87	6.82	6.78	
35	6.95	6.90	6.85	6.80	6.76	6.71	6.66	
36	6.84	6.79	6.76	6.70	6.65	6.60	6.55	
37	6.73	6.68	6.64	6.59	6.54	6.49	6.45	
38	6.63	6.58	6.54	6.49	6.44	6.40	6.35	
39	6.52	6.47	6.43	6.38	6.35	6.29	6.24	
40	6.42	6.37	6.33	6.28	6.24	6.19	6.15	
41	6.32	6.27	6.23	6.18	6.14	6.09	6.05	
42	6.22	6.18	6.13	6.09	6.04	6.00	5.95	
43	6.13	6.09	6.04	6.00	5.95	5.91	5.87	
44	6.03	5.99	5.94	5.90	5.86	5.81	5.77	
45	5.94	5.90	5.85	5.81	5.77	5.72	5.68	

Table taken from EPA Region I SOP, Draft Calibration of Field Instruments, June 3, 1998.

Oxygen Solubility at Indicated Pressure
(Page 2 of 2)

Oxygen Solubility at Indicated Pressure (continued)

Temp.	Pressure (Hg)								
	725	720	715	710	705	700	695	690	mm
°C	28.54	28.35	28.15	27.95	27.76	27.56	27.36	27.17	in
0	13.89	13.80	13.70	13.61	13.51	13.41	13.32	13.22	mg/l
1	13.51	13.42	13.33	13.23	13.14	13.04	12.95	12.86	
2	13.15	13.06	12.07	12.88	12.79	12.69	12.60	12.51	
3	12.81	12.72	12.63	12.54	12.45	12.36	12.27	12.18	
4	12.47	12.39	12.30	12.21	12.13	12.04	11.95	11.87	
5	12.15	12.06	11.98	11.89	11.81	11.73	11.64	11.56	
6	11.84	11.73	11.68	11.60	11.51	11.43	11.35	11.27	
7	11.55	11.47	11.39	11.31	11.22	11.14	11.06	10.98	
8	11.26	11.18	11.10	11.02	10.95	10.87	10.79	10.71	
9	10.99	10.92	10.84	10.76	10.69	10.61	10.53	10.46	
10	10.74	10.66	10.59	10.51	10.44	10.36	10.29	10.21	
11	10.48	10.40	10.33	10.28	10.18	10.11	10.04	9.96	
12	10.24	10.17	10.10	10.02	9.95	9.88	9.81	9.46	
13	10.01	9.94	9.87	9.80	9.73	9.66	9.59	9.52	
14	9.79	9.72	9.65	9.68	9.51	9.45	9.38	9.31	
15	9.58	9.51	9.44	9.58	9.31	9.24	9.18	9.11	
16	9.37	9.30	9.24	9.17	9.11	9.04	8.97	8.91	
17	9.18	9.11	9.05	8.98	8.92	8.85	8.79	8.73	
18	8.99	8.92	8.86	8.80	8.73	8.67	8.61	8.54	
19	8.81	8.74	8.68	8.62	8.56	8.49	8.43	8.37	
20	8.63	8.57	8.51	8.45	8.39	8.33	8.27	8.21	
21	8.46	8.40	8.34	8.28	8.22	8.16	8.10	8.04	
22	8.30	8.24	8.18	8.12	8.06	8.00	7.95	7.89	
23	8.15	8.09	8.03	7.97	7.91	7.86	7.80	7.74	
24	7.99	7.94	7.88	7.82	7.76	7.71	7.65	7.59	
25	7.85	7.79	7.74	7.68	7.60	7.57	7.51	7.46	
26	7.70	7.65	7.59	7.54	7.48	7.43	7.37	7.32	
27	7.57	7.52	7.46	7.41	7.35	7.30	7.25	7.19	
28	7.44	7.38	7.33	7.28	7.22	7.17	7.12	7.06	
29	7.31	7.26	7.21	7.15	7.10	7.05	7.00	6.94	
30	7.19	7.14	7.08	7.03	6.98	6.93	6.88	6.82	
31	7.06	7.01	6.96	6.91	6.86	6.81	6.76	6.70	
32	6.95	6.90	6.85	6.80	6.70	6.70	6.64	6.59	
33	6.83	6.78	6.73	6.68	6.83	6.58	6.53	6.48	
34	6.73	6.68	6.63	6.58	6.53	6.48	6.43	6.38	
35	6.61	6.56	6.51	6.47	6.42	6.37	6.36	6.27	
36	6.51	6.46	6.41	6.36	6.31	6.27	6.22	6.17	
37	6.40	6.35	6.31	6.26	6.21	6.16	6.12	6.07	
38	6.30	6.26	6.21	6.16	6.12	6.07	6.02	5.98	
39	6.26	6.15	6.11	6.06	6.01	5.97	5.92	5.87	
40	6.10	6.06	6.01	5.96	5.92	5.86	5.83	5.78	
41	6.00	5.96	5.91	5.87	5.82	5.78	5.73	5.69	
42	5.91	5.86	5.82	5.77	5.73	5.69	5.64	5.60	
43	5.82	5.78	5.73	5.69	5.65	5.60	5.56	5.51	
44	5.72	5.68	5.64	5.59	5.55	5.51	5.46	5.42	
45	5.64	5.59	5.55	5.51	5.47	5.42	5.38	5.34	

Table taken from EPA Region I SOP, Draft Calibration of Field Instruments, June 3, 1998.

Attachment C
Zobell Temperature Correction Chart
(ORP Calibration)

Zobell Temperature Correction Chart
(ORP Calibration)

Zobell Temperature Correction Chart

Temperature (Celcius)	Corrected Zobell Reading (mV)
-5	270.0
-4	268.7
-3	267.4
-2	266.1
-1	264.8
0	263.5
1	262.2
2	260.9
3	259.6
4	258.3
5	257.0
6	255.7
7	254.4
8	253.1
9	251.8
10	250.5
11	249.2
12	247.9
13	246.6
14	245.3
15	244.0
16	242.7
17	241.4
18	240.1
19	238.8
20	237.5
21	236.2
22	234.9
23	233.6
24	232.3
25	231.0
26	229.7
27	228.4
28	227.1
29	225.8
30	224.5
31	223.2
32	221.9
33	220.6
34	219.3
35	218.0
36	216.7
37	215.4
38	214.1
39	212.8
40	211.5

Table taken from EPA Region I SOP, Draft Calibration of Field Instruments, June 3, 1998.

Attachment D
TRC Field Instrument Calibration Log

PAGE _____ OF _____

WATER QUALITY METER CALIBRATION LOG

PROJECT NAME:	MODEL:	SAMPLER:
PROJECT NO.:	SERIAL #:	DATE:

PH CALIBRATION CHECK

pH 7 (LOT #): (EXP. DATE): POST-CAL. READING / STANDARD	pH 4 / 10 (LOT #): (EXP. DATE): POST-CAL. READING / STANDARD	CAL. RANGE	TIME
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	

SPECIFIC CONDUCTIVITY CALIBRATION CHECK

CAL. READING (LOT #): (EXP. DATE): POST-CAL. READING / STANDARD	TEMPERATURE (°CELSIUS)	CAL. RANGE	TIME
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	

ORP CALIBRATION CHECK

CAL. READING (LOT #): (EXP. DATE): POST-CAL. READING / STANDARD	TEMPERATURE (°CELSIUS)	CAL. RANGE	TIME
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	
/		☐ WITHIN RANGE	

D.O. CALIBRATION CHECK

CALIBRATION READING (mg/L)	CAL. RANGE	TIME
	☐ WITHIN RANGE	
	☐ WITHIN RANGE	
	☐ WITHIN RANGE	
	☐ WITHIN RANGE	

TURBIDITY CALIBRATION CHECK

CALIBRATION READING (NTU) (LOT #): (EXP. DATE): POST-CAL. READING / STANDARD	(LOT #): (EXP. DATE): POST-CAL. READING / STANDARD	CAL. RANGE	TIME
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	
/	/	☐ WITHIN RANGE	

COMMENTS

☐ AUTOCAL SOLUTION (LOT #): (EXP. DATE):	☐ STANDARD SOLUTION (S) LIST LOT NUMBERS AND EXPIRATION DATES UNDER CALIBRATION CHECK
CALIBRATED PARAMETERS	**CALIBRATION RANGES [1]**
☐ pH	pH: +/- 0.2 S.U.
☐ COND	COND: +/- 1% OF CAL. STANDARD
☐ ORP	ORP: +/- 25 mV
☐ D.O.	D.O.: VARIES
☐ TURB	TURB: +/- 5% OF CAL. STANDARD
☐ _____	[1] CALIBRATION RANGES ARE SPECIFIC TO THE MODEL OF THE WATER QUALITY METER
☐ _____	

NOTES

PROBLEMS ENCOUNTERED	CORRECTIVE ACTIONS

SIGNED _____ DATE _____

CHECKED BY _____ DATE _____

REVISED 03/2008

Attachment 2
Example Field Data Forms

PROJECT NAME: _____

PROJECT NUMBER: _____

PROJECT MANAGER: _____

SITE LOCATION: _____

_____

DATES OF FIELDWORK: _____

_____

_____

PURPOSE OF FIELDWORK: _____

_____

_____

_____

_____

WORK PERFORMED BY: _____

_____

_____

_____

_____

SIGNED DATE CHECKED BY DATE

GENERAL NOTES

PROJECT NAME:	DATE:	TIME ARRIVED:
PROJECT NUMBER:	AUTHOR:	TIME LEFT:

WEATHER		
TEMPERATURE: _____ °F	WIND: _____ MPH	VISIBILITY: _____

WORK / SAMPLING PERFORMED

PROBLEMS ENCOUNTERED	CORRECTIVE ACTION TAKEN

COMMUNICATION		
NAME	REPRESENTING	SUBJECT / COMMENTS

SIGNED _____ DATE _____

CHECKED BY _____ DATE _____

METER CALIBRATION

PROJECT NAME:	MODEL:	SAMPLER:
PROJECT NO.:	SERIAL #:	DATE:

PH METER

BUFFER CALIBRATION		TIME	END OF DAY BUFFER CHECK		TIME	Date
pH 4	pH 7		pH 4	pH 7		

Calibrate at beginning of day and check buffer readings at end of day.

CONDUCTIVITY METER

SOLUTION TEMP.	CALIBRATION CORRECTED @ 25°C	TIME	SOLUTION TEMP.	END OF DAY CHECK CORRECTED @ 25°C	TIME	Date

Calibrate at beginning of day and check solution reading at end of day.

DISSOLVED OXYGEN METER

CALIBRATION (mg/L)	TIME	CALIBRATION (mg/L)	TIME	Date

Calibrate twice daily.

REDOX METER

SOLUTION TEMP.	ORP (MV)	TIME	SOLUTION TEMP.	END OF DAY CHECK (MV)	TIME	Date

Calibrate at beginning of day and check solution reading at end of day.

TURBIDITY METER

GEL VALUE (NTU) 0-10	GEL VALUE (NTU) 0-100	GEL VALUE (NTU) 0-1000	TIME	Date

Check Calibration once daily.

Autocal Solution: Lot #: _____, Exp. Date:_____

pH 7 Solution: Lot #: _____, Exp. Date:_____

ORP Solution: Lot #: _____, Exp. Date:_____

COMMENTS

SIGNED DATE

CHECKED BY DATE

PID FIELD CALIBRATION LOG

PROJECT NAME:	MODEL:
PROJECT NUMBER.:	LAMP VOLTAGE:
SAMPLER NAME:	SERIAL NO.:

PID CALIBRATION CHECK

	DATE: TIME: INITIALS:	DATE: TIME: INITIALS:	DATE: TIME: INITIALS:	DATE: TIME: INITIALS:	DATE: TIME: INITIALS:
BATTERY CHECK	☐	☐	☐	☐	☐
ZERO GAS	/	/	/	/	/
SPAN GAS	/	/	/	/	/
AUDIBLE FAN MOTOR CHECK	☐	☐	☐	☐	☐
RESPONSE CHECK	☐	☐	☐	☐	☐

NOTES

PROBLEMS ENCOUNTERED	CORRECTIVE ACTION

SIGNED DATE CHECKED DATE

WATER LEVEL DATA

PROJECT NAME:	DATE:
PROJECT NUMBER:	AUTHOR:

WELL LOCATION	TIME	GROUND SURFACE ELEVATION (FEET)	REFERENCE ELEVATION (FEET)	DEPTH TO WATER (FEET)	DEPTH TO BOTTOM (FEET)	WATER ELEVATION

ALL WATER LEVELS MUST INCLUDE REFERENCE POINT AND TAPE CORRECTION FACTOR (E.G., 1.1 + 0.00 T/PVC).

SIGNED DATE

CHECKED DATE

WATER SAMPLE LOG

PROJECT NAME:	PREPARED		CHECKED	
PROJECT NUMBER:	BY:	DATE:	BY:	DATE:

SAMPLE ID: WELL DIAMETER: ☐ 2" ☐ 4" ☐ 6" ☐ OTHER _____

WELL MATERIAL: ☐ PVC ☐ SS ☐ IRON ☐ GALVANIZED STEEL ☐ OTHER _____

SAMPLE TYPE: ☐ GW ☐ WW ☐ SW ☐ DI ☐ LEACHATE ☐ OTHER _____

PURGING	TIME:	DATE:	SAMPLE	TIME:	DATE:

PURGE METHOD: ☐ PUMP BLADDER PUMP (DEDICATED) ☐ BAILER _____

PH: _____ SU | CONDUCTIVITY: _____ umhos/cm

ORP: _____ mV | DO: _____ mg/L

DEPTH TO WATER: _____ T/ PVC

DEPTH TO BOTTOM: _____ T/ PVC

TURBIDITY: _____NTU

☐ NONE ☐ SLIGHT ☐ MODERATE ☐ VERY

WELL VOLUME: _____ ☐ LITERS ☐ GALLONS | TEMPERATURE: _____ °C | OTHER: _____

VOLUME REMOVED: _____ ☐ LITERS ☐ GALLONS | COLOR: _____ | ODOR: _____

COLOR: _____ ODOR: _____ | FILTRATE (0.45 um) ☐ YES ☐ NO

TURBIDITY ☐ NONE ☐ SLIGHT ☐ MODERATE ☐ VERY | FILTRATE COLOR: _____ | FILTRATE ODOR: _____

QC SAMPLE: ☐ MS/MSD ☐ DUP- _____

DISPOSAL METHOD: ☐ GROUND ☐ Tank ☐ OTHER | COMMENTS: Fe ppm:_____ CO_2 ppm:_____ Alk. ppm:_____

TIME	PURGE RATE (ML/MIN)	TEMPERATURE (°C)	CONDUCTIVITY (umhos/cm)	D.O. (mg/L)	pH (SU)	ORP (mV)	TURBIDITY (NTU)	WATER LEVEL (FEET)	CUMULATIVE PURGE VOLUME (GAL OR L)
									INITIAL

BOTTLES FILLED — PRESERVATIVE CODES A - NONE B - HNO3 C - H2SO4 D - NaOH E - HCL F - _____

NUMBER	SIZE	TYPE	PRESERVATIVE	FILTERED	NUMBER	SIZE	TYPE	PRESERVATIVE	FILTERED
				☐ Y ☐ N					☐ Y ☐ N
				☐ Y ☐ N					☐ Y ☐ N
				☐ Y ☐ N					☐ Y ☐ N
				☐ Y ☐ N					☐ Y ☐ N
				☐ Y ☐ N					☐ Y ☐ N

SHIPPING METHOD: _____	DATE SHIPPED: _____	
	SIGNATURE: _____	DATE SIGNED: _____

WATER SAMPLE LOG

(CONTINUED FROM PREVIOUS PAGE)

PROJECT NAME:	PREPARED		CHECKED	
PROJECT NUMBER:	BY:	DATE:	BY:	DATE:

SAMPLE ID:

TIME	PURGE RATE (ML/MIN)	TEMPERATURE (°C)	CONDUCTIVITY (umhos/cm)	D.O. (mg/L)	pH (SU)	ORP (mV)	TURBIDITY (NTU)	WATER LEVEL (FEET)	CUMULATIVE PURGE VOLUME (GAL OR L)

SIGNATURE: _____ DATE SIGNED: _____

SEDIMENT / SOIL GRAB SAMPLE LOG

PROJECT NAME:	PREPARED		CHECKED	
PROJECT NUMBER:	BY:	DATE:	BY:	DATE:

SAMPLE ID:	COLLECTED BY:
DATE COLLECTED:	SAMPLE TYPE: ☐ SEDIMENT ☐ SOIL ☐ OTHER _____
TIME COLLECTED:	QC SAMPLE: ☐ MS/MSD ☐ DUP- _____

SAMPLE LOCATION	SAMPLE COORDINATES
	NORTHING / LATITUDE:
	EASTING / LONGITUDE:

SAMPLE CONTAINERS:

SAMPLE EQUIPMENT:

SAMPLE SCREENING EQUIPMENT: ☐ PID ☐ GAMMA DETECTOR ☐ FID ☐ OTHER _____ NOTES: _____

SAMPLE SCREENING RESULTS: _____ ☐ PPM ☐ OTHER _____

SAMPLE DESCRIPTION:

ADDITIONAL NOTES:

SHIPPING METHOD: _____	DATE SHIPPED: _____	AIRBILL NUMBER: _____
COC NUMBER: _____	SIGNATURE: _____	DATE SIGNED: _____

AIR / VAPOR SAMPLE LOG

PROJECT NAME:	PREPARED	CHECKED
PROJECT NUMBER:	BY: DATE:	BY: DATE:

SAMPLE INFORMATION			
SAMPLE TYPE: ☐ COMPOSITE ☐ GRAB	**SAMPLE ID:**		
SAMPLE MEDIA ☐ INDOOR AIR ☐ SOIL VAPOR ☐ SYSTEM PERFORMANCE ☐ OTHER	LOCATION:	LOCATION COORDINATES: N: E:	
SAMPLE DURATION:	SAMPLE HEIGHT / (DEPTH):		
SAMPLE CONTAINER TYPE: ☐ SUMMA CANISTER ☐ TEDLAR BAG ☐ OTHER:			
FLOW VALVE ID / SERIAL NUMBER:	CANISTER SERIAL NUMBER:		

READING	TIME	VACUUM (INCHES - Hg / PSIG)	DATE	INITIALS	COMMENTS
INITIAL VACUUM CHECK					
INITIAL FIELD VACUUM					
FINAL FIELD VACUUM					

SAMPLE START TIME:	SAMPLE STOP TIME:

NOTES AND OBSERVATIONS
MOTORIZED VEHICLE STORAGE :
MOTORIZED VEHICLE TRAFFIC:
OPERATIONS (e.g., painting, oil recovery):
CLEANERS / SOLVENTS IN USE:
MATERIAL STORAGE (e.g., paint, gasoline):
NOTICEABLE ODORS:
AUDIBLE OR NEARBY HVAC OPERATION:
OTHER:

ADDITIONAL COMMENTS:

SHIPPING METHOD: _____	DATE SHIPPED: _____	AIRBILL NUMBER: _____
COC NUMBER: _____	SIGNATURE: _____	DATE SIGNED: _____

TRC

LOG OF SOIL BORING

PROJECT NAME:	**SOIL BORING ID:**	
PROJECT NUMBER:	LOCATION:	SHEET 1 OF
LOGGED BY:		SURFACE ELEV.:
PROJECT LOCATION:	N: E:	DATE STARTED:
DRILLED BY:	DRILLER NAME:	DATE COMPLETED:

NO.	TYPE	%	BLOWS	PID	DEPTH	VISUAL CLASSIFICATION AND OBSERVATIONS	COMMENT

DRILLING METHOD
DRILL RIG
BORING DIAMETER

WATER LEVEL OBSERVATIONS			
FIRST OCCURRENCE:			
DATE	TIME	DEPTH TO WATER	DEPTH TOBOTTOM

SIGNED DATE

CHECKED DATE

REVISED 03/2008

TRC

LOG OF SOIL BORING

SHEET	OF

PROJECT NAME:	**SOIL BORING ID:**

NO.	TYPE	%	BLOWS	PID	DEPTH	VISUAL CLASSIFICATION AND OBSERVATIONS	COMMENT

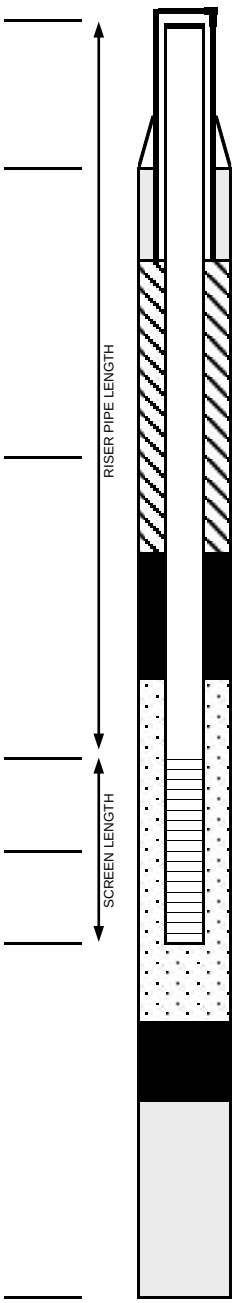
SIGNED _____ DATE _____

CHECKED _____ DATE _____

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:		WELL ID:	
PROJ. NO:	DATE INSTALLED:	INSTALLED BY:	CHECKED BY:

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)



_____ TOP OF CASING

0.0 GROUND SURFACE

_____ CEMENT SURFACE PLUG

GROUT/BACKFILL MATERIAL

GROUT/BACKFILL METHOD

_____ GROUT

BENTONITE SEAL MATERIAL

_____ BENTONITE SEAL

_____ TOP OF SCREEN

FILTER PACK MATERIAL

_____ BOTTOM OF SCREEN

_____ BOTTOM OF FILTER PACK

_____ BENTONITE PLUG

BACKFILL MATERIAL

_____ HOLE BOTTOM

NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: _____

PIPE SCHEDULE: _____

PIPE JOINTS: _____

SOLVENT USED? _____

SCREEN TYPE: _____

SCR. SLOT SIZE: _____

BOREHOLE DIAMETER: _____ IN. FROM _____ TO _____ FT.
_____ IN. FROM _____ TO _____ FT.

SURF. CASING DIAMETER: _____ IN. FROM _____ TO _____ FT.
_____ IN. FROM _____ TO _____ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: _____

TIME DEVELOPING: _____ HOURS

WATER REMOVED: _____ GALLONS

WATER ADDED: _____ GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: _____

COLOR BEFORE: _____

CLARITY AFTER: _____

COLOR AFTER: _____

ODOR (IF PRESENT): _____

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:		T/PVC		
DTB AFTER DEVELOPING:		T/PVC		
SWE BEFORE DEVELOPING:		T/PVC		
SWE AFTER DEVELOPING:		T/PVC		
OTHER SWE:		T/PVC		
OTHER SWE:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☐ YES ☐ NO

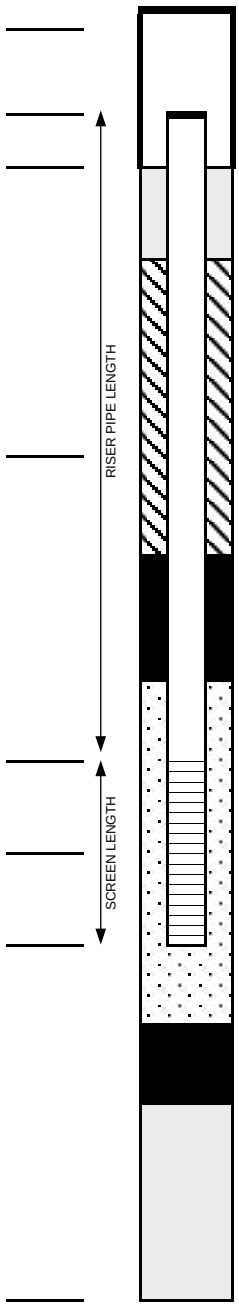
PROTECTIVE COVER AND LOCK INSTALLED? ☐ YES ☐ NO

LOCK KEY NUMBER: _____

WELL CONSTRUCTION DIAGRAM

PROJ. NAME:		WELL ID:	
PROJ. NO:	DATE INSTALLED:	INSTALLED BY:	CHECKED BY:

ELEVATION (BENCHMARK: USGS)	DEPTH BELOW OR ABOVE GROUND SURFACE (FEET)



0.0 GROUND SURFACE

TOP OF CASING

CEMENT SURFACE PLUG

GROUT/BACKFILL MATERIAL

GROUT/BACKFILL METHOD

GROUT

BENTONITE SEAL MATERIAL

BENTONITE SEAL

TOP OF SCREEN

FILTER PACK MATERIAL

BOTTOM OF SCREEN

BOTTOM OF FILTER PACK

BENTONITE PLUG

BACKFILL MATERIAL

HOLE BOTTOM

NOTES:

CASING AND SCREEN DETAILS

TYPE OF RISER: _____

PIPE SCHEDULE: _____

PIPE JOINTS: _____

SOLVENT USED? _____

SCREEN TYPE: _____

SCR. SLOT SIZE: _____

BOREHOLE DIAMETER: _____ IN. FROM _____ TO _____ FT.
_____ IN. FROM _____ TO _____ FT.

SURF. CASING DIAMETER: _____ IN. FROM _____ TO _____ FT.
_____ IN. FROM _____ TO _____ FT.

WELL DEVELOPMENT

DEVELOPMENT METHOD: _____

TIME DEVELOPING: _____ HOURS

WATER REMOVED: _____ GALLONS

WATER ADDED: _____ GALLONS

WATER CLARITY BEFORE / AFTER DEVELOPMENT

CLARITY BEFORE: _____

COLOR BEFORE: _____

CLARITY AFTER: _____

COLOR AFTER: _____

ODOR (IF PRESENT): _____

WATER LEVEL SUMMARY

MEASUREMENT (FEET)			DATE	TIME
DTB BEFORE DEVELOPING:		T/PVC		
DTB AFTER DEVELOPING:		T/PVC		
SWE BEFORE DEVELOPING:		T/PVC		
SWE AFTER DEVELOPING:		T/PVC		
OTHER SWE:		T/PVC		
OTHER SWE:		T/PVC		

PROTECTIVE CASING DETAILS

PERMANENT, LEGIBLE WELL LABEL ADDED? ☐ YES ☐ NO

PROTECTIVE COVER AND LOCK INSTALLED? ☐ YES ☐ NO

LOCK KEY NUMBER: _____

WELL INSPECTION REPORT

PROJECT NAME:	0
PROJECT NO.:	0.00

SAMPLER NAME:
DATE:

WELL ID	PROTECTIVE CASING	SURFACE SEAL	DEGREE OF IMMOBILITY OF PROTECTIVE CASING	PERMANENT LEGIBLE LABELS	LOCK	WELL CAP	EASE OF INSERTING / REMOVING BAILER	SEDIMENT IN WELL	COMMENT

SIGNED DATE

CHECKED BY DATE

14/16

CHAIN OF CUSTODY

ALS Environmental
1317 South 13th Ave., Kelso, WA 98626 | 360.577.7222 | 800.695.7222 | 360.636.1068 (fax)

SR# _____

PAGE _____ OF _____ COC# _____

PROJECT NAME
PROJECT NUMBER
PROJECT MANAGER
COMPANY NAME
ADDRESS
CITY/STATE/ZIP
E-MAIL ADDRESS
PHONE # FAX #
SAMPLER'S SIGNATURE

SAMPLE I.D.	DATE	TIME	LAB I.D.	MATRIX	NUMBER OF CONTAINERS	Semivolatile Organics by GC/MS 625☐ 8270☐ 8270LL☐ SIM PAH☐	Volatile Organics 624☐ 8260☐ 8021☐ BTEX☐	Hydrocarbons (*see below) Gas☐ Diesel☐ Oil☐	Oil & Grease/TRPH 1664 HEM☐ 1664 SGT☐	PCBs Aroclors☐ Congeners☐	Pesticides/Herbicides 608☐ 8081☐ 8141☐ 8151☐	Chlorophenolics - 8151M Tri☐ Tetra☐ PCP☐	Metals, Total or Dissolved (See List below)	Cyanide☐ Hex-Chrom☐	(circle) pH, Cond., Cl, SO_4, PO_4, F, NO_2, NO_3, BOD, TSS, TDS, Turb.	(circle) NH_3-N, COD, TKN, TOC, DOC, NO_2+NO_3, T-Phos	TOX 9020☐ AOX 1650☐ 506☐	Alkalinity☐ CO_3☐ HCO_3☐	Dioxins/Furans 1613☐ 8290☐	Dissolved Gases CO_2☐ RSK 175☐Methane☐Ethane☐ Ethene☐			REMARKS

REPORT REQUIREMENTS

___ I. Routine Report: Method Blank, Surrogate, as required
___ II. Report Dup., MS, MSD as required
___ III. CLP Like Summary (no raw data)
___ IV. Data Validation Report
___ V. EDD

INVOICE INFORMATION

P.O. # _____
Bill To: _____

TURNAROUND REQUIREMENTS

_____ 24 hr. _____ 48 hr.
_____ 5 day
_____ Standard (15 working days)

_____
Requested Report Date

Circle which metals are to be analyzed:

Total Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

Dissolved Metals: Al As Sb Ba Be B Ca Cd Co Cr Cu Fe Pb Mg Mn Mo Ni K Ag Na Se Sr Tl Sn V Zn Hg

***INDICATE STATE HYDROCARBON PROCEDURE: AK CA WI NORTHWEST OTHER: _____ (CIRCLE ONE)**

SPECIAL INSTRUCTIONS/COMMENTS:

☐ Sample Shipment contains USDA regulated soil samples (check box if applicable)

RELINQUISHED BY:		RECEIVED BY:		RELINQUISHED BY:		RECEIVED BY:	
Signature	Date/Time	Signature	Date/Time	Signature	Date/Time	Signature	Date/Time
Printed Name	Firm	Printed Name	Firm	Printed Name	Firm	Printed Name	Firm

15/16

Environmental Chemistry Consulting Services, Inc.
2525 Advance Road
Madison, WI 53718
608-221-8700 (phone)
608-221-4889 (fax)

CHAIN OF CUSTODY

Lab Work Order #:

Project Number:
Project Name:
Project Location:
Turn Around (check one): ☐ Normal ☐ 5 BDs ☐ 3 BDs ☐ 2 BDs ☐ 24 hrs
If Rush, Report Due Date:
Sampled By (Print):

Mail Report To:
Company:
Address:
E-mail Address:
Invoice To:
Company:
Address:

Preservation Codes
Analyses Requested

Sample Description	Collection Date	Collection Time	Matrix	Total # of Containers							Comments	Lab ID	Lab Receipt Time
					☐	☐	☐	☐	☐	☐			
					☐	☐	☐	☐	☐	☐			
					☐	☐	☐	☐	☐	☐			
					☐	☐	☐	☐	☐	☐			
					☐	☐	☐	☐	☐	☐			
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					☐	☐	☐	☐	☐	☐			
					☐	☐	☐	☐	☐	☐			
					☐	☐	☐	☐	☐	☐			

Preservation Codes
A=None B=HCL C=H_2SO_4
D=HNO_3 E=EnCore F=Methanol
G=NaOH O=Other (Indicate)

Matrix Codes
A=Air S=Soil W=Water O=Other

Rush TAT Multipliers
5 Business Days = 1.5x
3 Business Days = 2x
2 Business Days = 2.25x
24 Hours = 2.5x
must be pre-arranged

Relinquished By:	Date:	Time:	Received By:	Date:	Time:
Relinquished By:	Date:	Time:	Received By:	Date:	Time:

Custody Seal: ☐ Present ☐ Absent ☐ Intact ☐ Not Intact
Seal #s:
Shipped Via:
Receipt Temp:
Temp Blank: ☐ Y ☐ N

Download this form at www.eccsmobilelab.com
WHITE - REPORT COPY YELLOW - LABORATORY COPY PINK - SAMPLER/SUBMITTER
Rev. 5/11